YOUR OFFICIAL RASPBERRY PI MAGAZINE

The MagPi

The official Raspberry Pi magazine

Issue 60 August 2017 raspberrypi.org/magpi

RASPBERRY PI TROUBLESHOOTING SPECIAL

Your essential guide to solving Raspberry Pi problems

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TURN A PI ZERO W INTO A WIRELESS USB DRIVE

Set up your own network storage device

HACK A FIDGET SPINNER INTO A GAME PAD

Toy transformed into amazing maze runner

MAKE YOUR OWN EARTHQUAKE MONITOR

Raspberry Pi Shake project detects quakes

GET CREATIVE

Build incredible works of art with Raspberry Pi

Also inside:

- UNICORN HAT HD, FLICK & EXAGEAR REVIEWED
- GET STARTED WITH SCRATCH 2.0 & THONNY
- USE THE SENSE HAT WITH MATPLOTLIB
- BUILD A RASPBERRY PI PHOTO BOOTH

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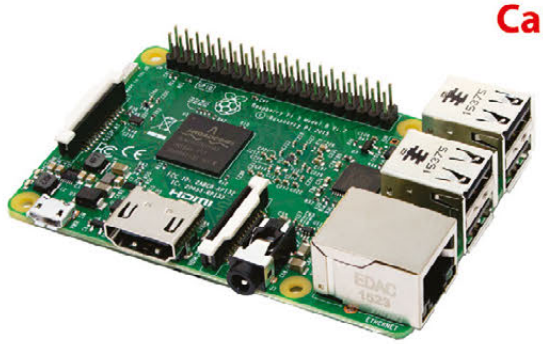

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WELCOME TO THE OFFICIAL MAGAZINE

The whole point of the Raspberry Pi is that you can muck it up and start again. That's what makes it an amazing computer for digital makers, coders, and hackers.

Being able to fix things is a vital skill for any computer buff, and you'll get lots of practise when using a Raspberry Pi. That's why we think you'll love this month's *Raspberry Pi Troubleshooting Special* (page 16). We wanted a troubleshooting guide for our workshop, and we thought you might like a copy in yours.

Digital makers are a pretty creative bunch, and there's a thin line between creative projects and artworks. Over the years, we've encountered many projects that verge on genius.

There's a lot to be said for making art with a Raspberry Pi, and we've got a lot to say on the subject this month in our *Get Creative* feature (page 67). If you're a digital artist looking to pick up some new skills, we'll show you how to integrate video, sound, light, and motion into your creations. It's a great tutorial if you're not an artist – in fact, especially if you're not an artist – as there are plenty of practical skills and tricks on show.

Whether you're fixing a technical hole in your project, or reaching for the creative stars, there's something for you in this issue.

Lucy Hattersley
Editor – The MagPi

FREE PI ZERO W WITH A SUBSCRIPTION! PAGE 28

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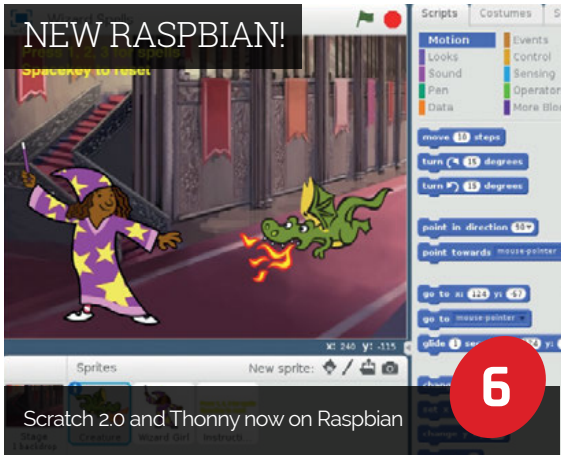

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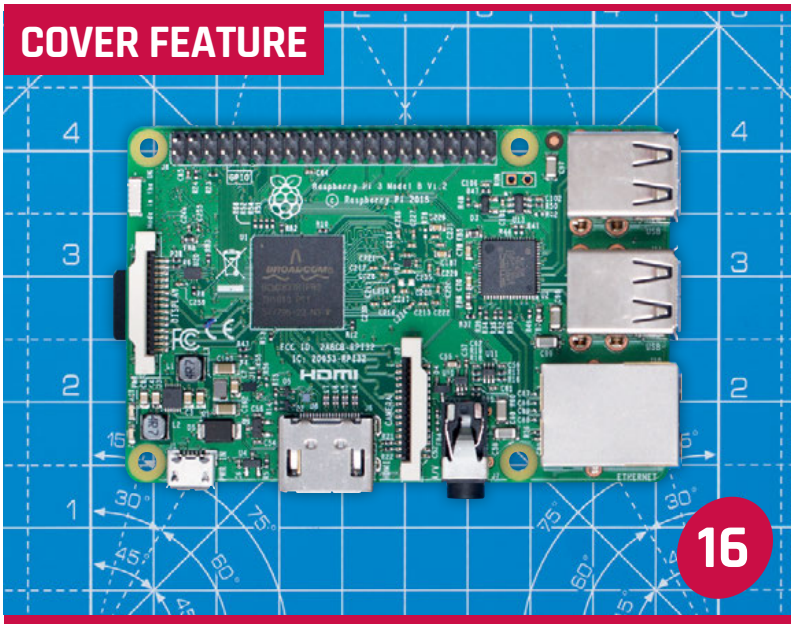

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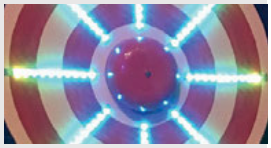

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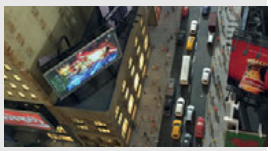

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NEW VERSION OF RASPBIAN WITH SCRATCH 2.0 AND THONNY

Raspbian update has the latest version of visual programming without the network requirement

A recent update to Raspbian has added an offline version of Scratch 2.0. Previously, only Scratch 1.4 was available offline, while Scratch 2.0 required an internet connection. The update means less hassle and cost for Code Clubs and CoderDojos, as well as anyone using Scratch at home.

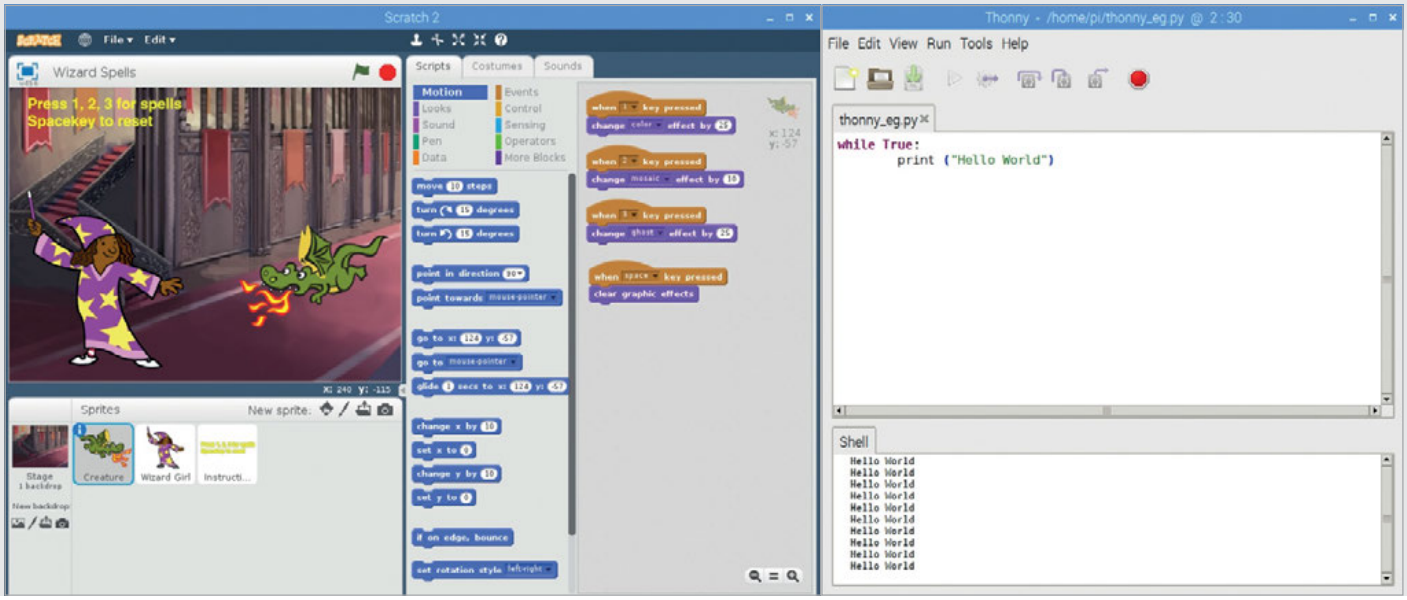
Simon Long, UX engineer for Raspbian, says: "Scratch is one of the most popular pieces of software on the Raspberry Pi", so the need to bring the latest version to Raspbian was clear. However, the latest version available from Scratch runs in Adobe Flash, which isn't supported by Raspbian.

Previously, Simon and the Raspberry Pi team "worked with Adobe to include the Pepper Flash plug-in in Raspbian", but that only enabled Scratch 2.0 to run online in the Chromium web browser. The need for a Pi to be online to use Scratch 2.0 excludes many possible Code Club and CoderDojo venues, as well as adding the cost and time of setting up the wireless connection on each Raspberry Pi.

For this update, Simon made use of the Electron framework (**electron.atom.io**). Electron is used to provide an environment in which a local copy of the Scratch 2.0 editor webpage can run as a standalone application.

Scratch 2.0 offers several new features. The Raspbian version also includes GPIO blocks, enabling easy access to the GPIO – see our tutorial, *Discover Scratch 2.0*, on page 40.

To install Scratch 2.0, open a Terminal and enter **`sudo apt-get install scratch2`**.



Introducing Thonny

There's also a new Python IDE to help develop your coding skills beyond visual programming. As Simon puts it, "It's fair to say that IDLE, the Python IDE, isn't the most popular piece of software ever written."

Simon assessed "20 or 30 IDEs in total over the course of 3-4 days," against a set of criteria. The chosen IDE would have to be easier for beginners, but still useful for experienced Python coders. He "didn't want to eliminate something based on an out-of-date description, only to find later that it was just what we wanted," so he downloaded every IDE onto a Pi and tested each one.

What was the process like? Simon replies, "In a word, terrible. That's a week of my life I am never getting back!"

> "Scratch is one of the most popular pieces of software on the Raspberry Pi"

Thonny was written by Aivar Annamaa, at the University of Tartu, Estonia. However, Aivar used Tkinter, Python's default GUI toolkit, so Simon worked with Aivar to make a version that has a visual style more in keeping with the GTK styling of Raspbian.

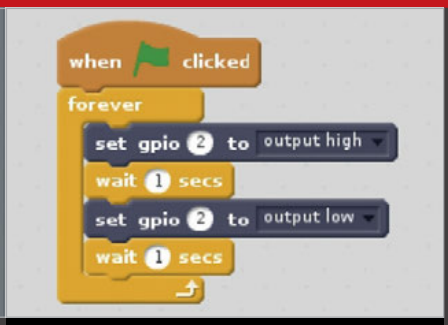
To install Thonny, open a Terminal window and enter **`sudo apt-get install python3-thonny`**.

Above left The new version of Scratch runs offline, and also makes physical computing easier

Above Thonny is the new Python IDE of choice for Raspbian

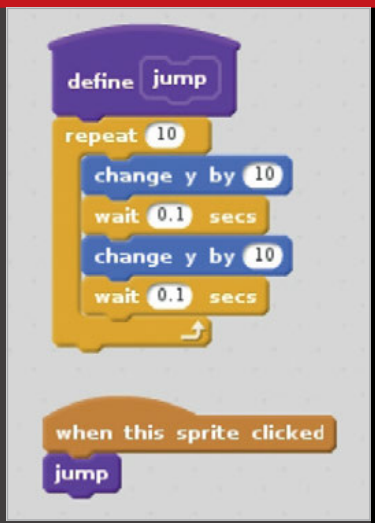
MOVING TO SCRATCH 2.0

Scratch 2.0 makes it easier to use the GPIO pins on the Pi. This image shows the Scratch code for a flashing LED in Scratch 1.4: terms such as 'broadcast' and 'config2out' are hardly intuitive.



To enable GPIO coding blocks, click on 'more blocks' and then add the Pi GPIO extension. You can now construct code more easily, with fewer blocks, and using terms that are easy to understand.

Scratch 2.0 introduces 'custom blocks' which can be used to define a function – a set of actions that can be used in a project, potentially many times. This example shows a custom block that makes a sprite jump.



RASPBERRY PI INTEGRATOR PROGRAMME

Quicker, easier and cheaper certification of your Pi-based product

The Raspberry Pi Foundation has launched the Raspberry Pi Integrator Programme to "help anyone get their Raspberry Pi-based product tested and on the market quickly and efficiently," says Roger Thornton, Principal Hardware Engineer.

Before a new product goes on sale, "it first has to prove that selling it is safe and legal." It is not sufficient to say that the Pi has been proved safe and legal, as there is more to a Pi-based product than just the Pi. For example, is the power supply safe? Is the Pi packaged in such a way that it might overheat? Does the casing of the product use safe, non-toxic, non-flammable materials?

However, "different countries usually have slightly different sets of regulations, and testing has to be conducted at an accredited facility for the region," Roger explains. The regulatory compliance process can be lengthy, costly, complex, and "especially taxing for smaller enterprises."

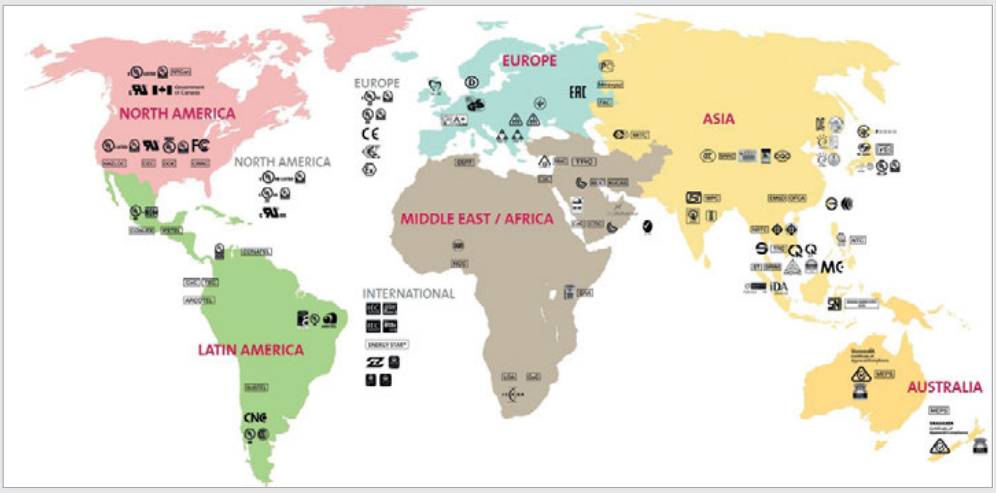
The Integrator Programme aims to cut through this burden by offering access to the same test engineers that the Raspberry Pi Foundation uses for its certification process, UL Certification (**ul-certification.com**).

"We have put the Integrator Programme in place in the hope of eliminating the burden of navigating complicated compliance issues," Roger said. "With simplified testing, companies and individuals can get products to market in less time and with lower overhead costs."

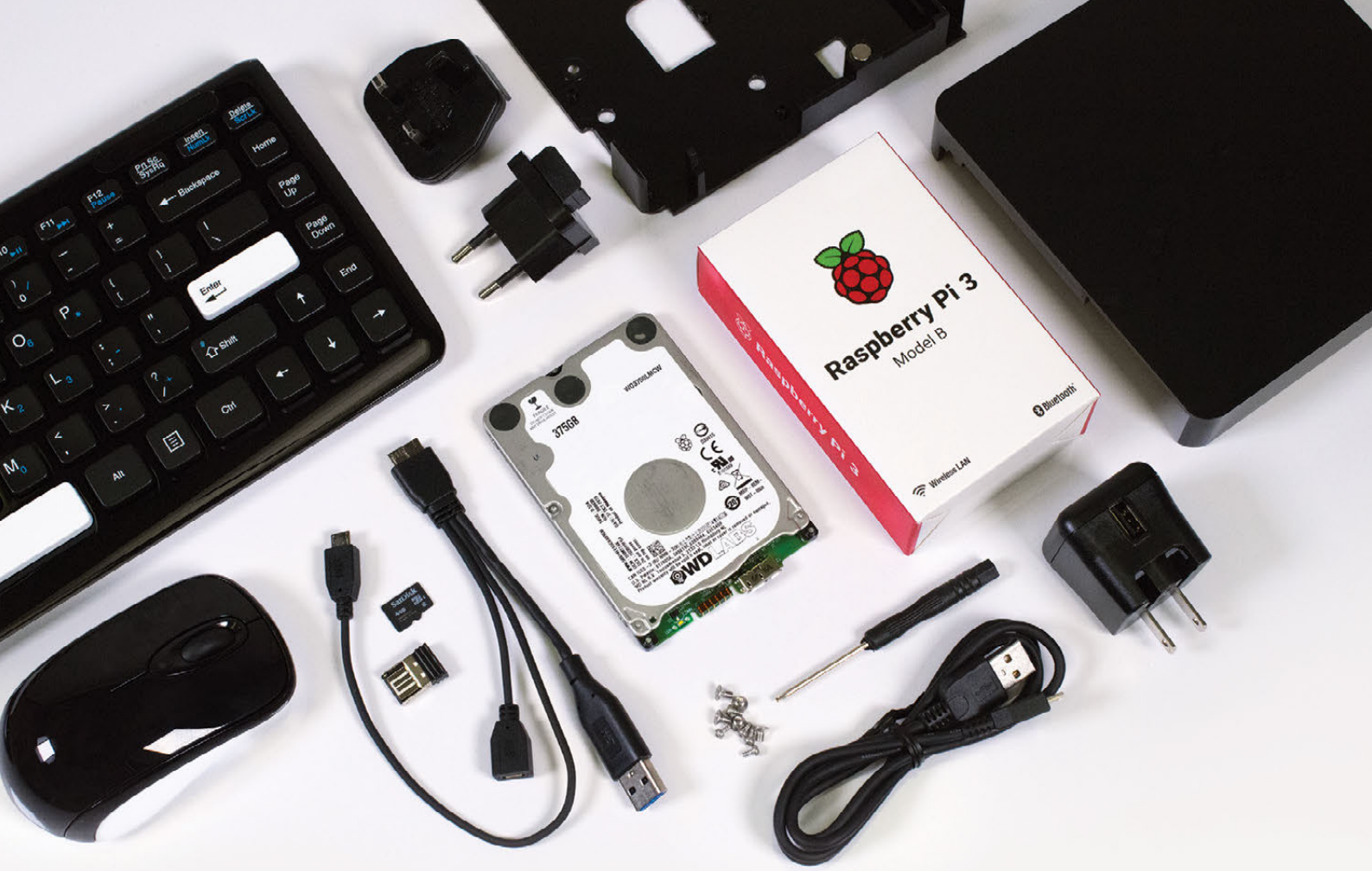
> "With simplified testing, companies and individuals can get products to market in less time and with lower overhead costs"

Furthermore, "our Integrator Programme is openly available," Roger confirms. "It comes with no added cost beyond the usual testing fees at UL." With UL's experience dealing with the Raspberry Pi hardware, you're already one step ahead of any other compliance company.

The Integrator Programme is accepting new clients already. Email **compliance@raspberrypi.org** with details of your Pi-based product. Don't forget about the Powered by Raspberry Pi programme, which shows customers that your product supports the Raspberry Pi Foundation's educational work via the use of a dedicated logo. See **magpi.cc/2smAAzN** for details.



Below Safety rules exist for a reason, but with so many variations, product certification can be a headache



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RASPBERRY PI WINS MACROBERT AWARD

Prestigious engineering prize awarded for 'sheer quality'

The MacRobert Award was accepted on behalf of the entire Raspberry Pi Foundation and community

As one of three finalists announced last month, the Raspberry Pi has won the 'most prestigious national prize for engineering innovation', the Royal Academy of Engineering's MacRobert Award.

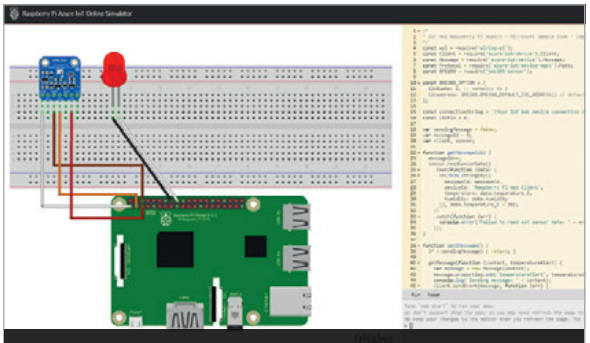
The Chair of the MacRobert judging panel, Dr Dame Sue Ion DBE FREng FRS, said, "What sets the Raspberry Pi apart is the sheer quality of innovation, which has allowed the computer to be used far beyond its original purpose."

The MacRobert Award is judged on three criteria: 'outstanding innovation, tangible societal benefit, and proven commercial success.' With sales of more than 13 million units, the "Raspberry Pi's original educational goal has actually resulted in a computer control system that can influence many different industries," according to Sue, while "communities in the developing world are being empowered by the Raspberry Pi."

Raspberry Pi co-founder Eben Upton says that winning the MacRobert Award "represents fantastic recognition for the ongoing work of Raspberry Pi, Code Club, CoderDojo, and the whole STEM education ecosystem."

MICROSOFT BUILDS RASPBERRY PI SIMULATOR

New online service could help with prototyping your next Raspberry Pi project



A free, simulated Raspberry Pi for prototyping your projects

Microsoft has created an online Raspberry Pi simulator to help Pi users prototype new builds. The simulator uses Microsoft's Azure platform to create and host a virtual Pi.

The service is still in its early stages. As Microsoft's Xin Shi explained via GitHub's Gitter chat service, "actually now the device and sensors on the left side is a static image."

There are plans to incorporate the ability to add other sensors, inputs, and outputs to the simulator. We can look forward to a "drag-and-drop experience on the left area" to add other elements to a simulated Pi build. However, as the whole project is open source, you could create your own electronics (**magpi.cc/2tdityO**).

Setting up the Pi simulator is a little convoluted. You'll need an Azure account (which is free for hobbyists), followed by a 13-step process just to run the basic simulation. Thankfully, Microsoft documents the process clearly at **magpi.cc/2ulWcNM.**

UBUNTU CORE FOR THE COMPUTE MODULE

Bespoke IoT operating system makes deployment and security easy

Ubuntu Core, Canonical's dedicated IoT operating system, is now available for the Raspberry Pi Compute Module 3 (CM3). Installing Core on CM3 is an "easy, cost-efficient route to the production of fully featured devices … while benefiting from the additional security of Ubuntu Core," according to Canonical.

Mike Bell, Canonical's EVP of Devices and IoT, added, "With CM3, the development of everything from an edge router, to a smart lift, to a next-generation vending machine or digital signage solution … is now as easy as developing a custom snap." A 'snap' is a 'universal Linux package for an app and all its dependencies'.

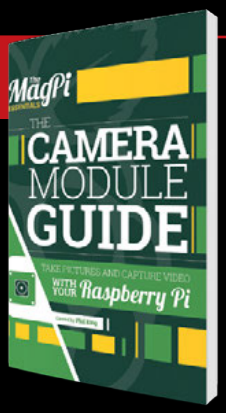
Core was previously available for the Raspberry Pi 2 and 3, but a Canonical spokesperson revealed to us that as "U-boot does not support CM3 out of the box," changes were needed in the boot stack order to achieve CM3 compatibility. You can build your own CM3-based Ubuntu Core device by following the guide at **magpi.cc/2smgBkM**.

Above Ubuntu Core can handle security and updates for Pi-based IoT devices

NOW TRENDING

The stories we shared that flew around the world

FREE CAMERA MODULE GUIDE



magpi.cc/2rJNsQ5

Our comprehensive guide to the Raspberry Pi Camera Module covers everything from installing the module to building exciting camera-based projects. Discover how to build a spy camera or produce live-streaming video.

NEW GOPIGO 3 ROBOT KIT

magpi.cc/2uGKLjb

Dexter's "totally redesigned" robot kit is "a lot more robust so you can daisy-chain and add on easily." The kit supports DexterOS, which is "designed specifically for learning how to program robots intuitively."

PI-BASED ENERGY MONITOR

magpi.cc/2tB2ufw

Welsh energy-monitoring specialist OpenEnergyMonitor (**openenergymonitor.org**) has announced a smart energy monitor that hooks into its Pi-based smart meter, the emonPi. Based on a NeoPixel ring and open-source technology, the emonPixel should be on sale soon.

FIRST THREE-COLOUR EINK HAT

Pimoroni Inky pHAT packs a visual punch without the power draw

Pimoroni's Inky pHAT uses a colour eInk screen for punchy, low-power visuals

Pimoroni has launched the first ever colour eInk HAT for the Raspberry Pi. The 2.13-inch screen can display red, white and black and costs £22 from **magpi.cc/2sIRNCE**.

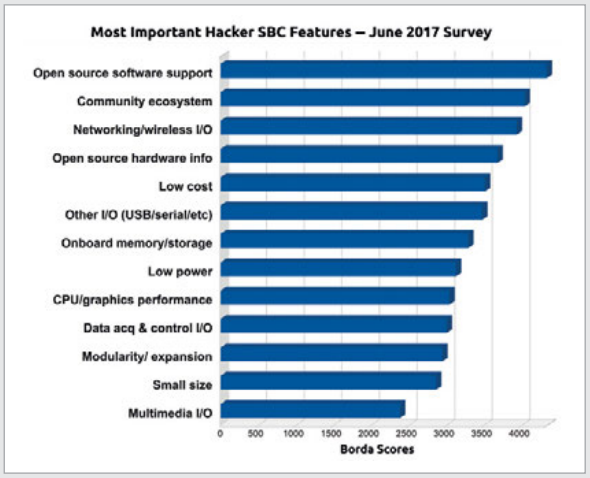
While the Inky pHAT offers zero power draw (spiking to 8 mA when the image changes), and readability under bright light, screen refreshes can take up to 15 seconds. That's still fine for a to-do list, calendar or similar project.

The Inky pHAT is a 60×30mm Pi Zero-sized HAT, but "you'll see a full range of screens, and the upcoming breakout board which is more suitable for custom projects," says Pimoroni Co-founder Paul Beech. "The sizes go from 'large stamp' to 'small book' size."

Colour eInk screens with yellow and blue have been around for a while, and Paul tells us, "other colours have been whispered about." However, he adds, "We think red was the obvious choice because it stands out in a retail setting."

RASPBERRY PI 3 VOTED 'MOST DESIRABLE'

Hackers rank Raspberry Pi the most popular single-board computer



Right The most important aspects of a single-board computer for hackers and makers

LinuxGizmos.com and Linux.com's 2017 Hacker Survey resulted in a huge win for the Raspberry Pi 3, with a score of 2,583 points. The second-placed Pi Zero W scored 648.

A Raspberry Pi of some form has won every Hacker Survey since the first, in 2014. LinuxGizmos editor Eric Brown tells us, "The huge margin of this year's victory was surprising. One reason may be that the Raspberry Pi 3 is the most competitive Pi yet."

"Also, community counts," Eric adds. "As the Pi community's membership balloons, you can find answers to your questions more easily than ever … Our survey respondents' top two buying criteria are open software support and community."

Eric acknowledges that "if you base a hardware or software product around the Pi … you can reduce the friction in everything from providing accessories to hiring knowledgeable developers."

VISUAL STUDIO CODE ON RASPBIAN

Visual Studio for Raspberry Pi updated

Hobbyist Jay Rodgers, better known online as 'headmelted', has overhauled his Visual Studio Code application for Raspbian and Chrome OS. The new build scripts ensure VS Code will be regularly updated, and with "the absolute minimum set of patches."

Asked why he wanted to bring VS Code to the Raspberry Pi, Jay tells us, "Tools like Vim or Emacs are not exactly targeted towards beginners (great as they are!)." Microsoft describes VS Code as "lightweight but powerful" and offers video guides to help get started (see **magpi.cc/2smkW7j**).

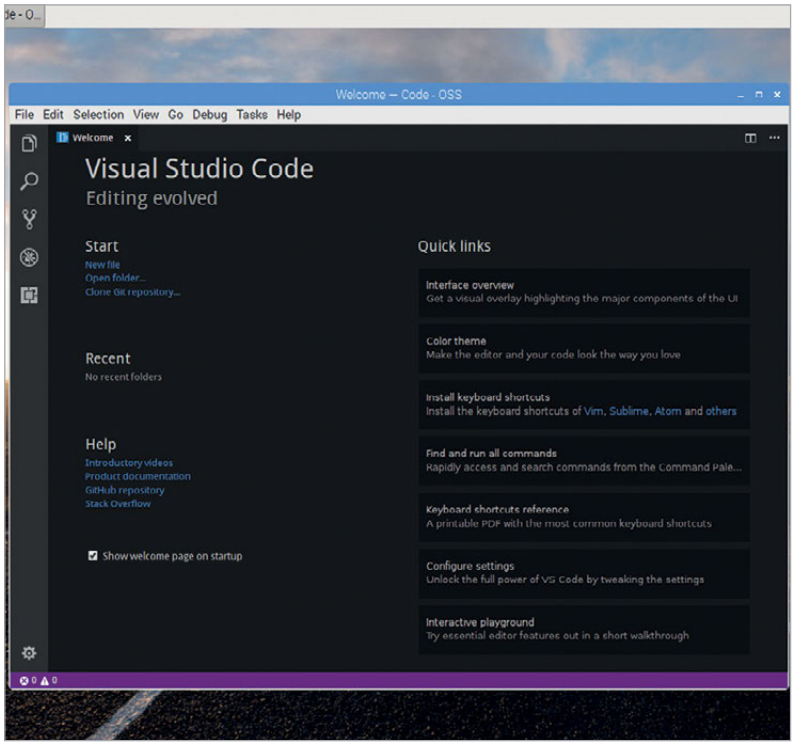
Jay adds that the overhaul was particularly timely, as "the developer community over the past year has really rallied around VS Code, and I don't want those folks on Raspbian to be neglected."

While anyone could use Electron to build a VS Code app, "there are a couple of catches with this," according to Jay, "among them that VS Code can take some time to build … and doing so is fraught with dependencies that are not usually present on Raspbian."

Jay's application installs via a single command (see **magpi.cc/2tdEn5g**), and also allows updates "that are broadly up to date with the VS Code Insiders release."

The developer community should "meet new users where they are," Jay urges, whether that's on a Pi or a Chromebook, and that means "making the best tools available as widely as we can."

Above Jay often works on coding projects with his son Benjamin (4, right). Zachary (1, centre) is still a little young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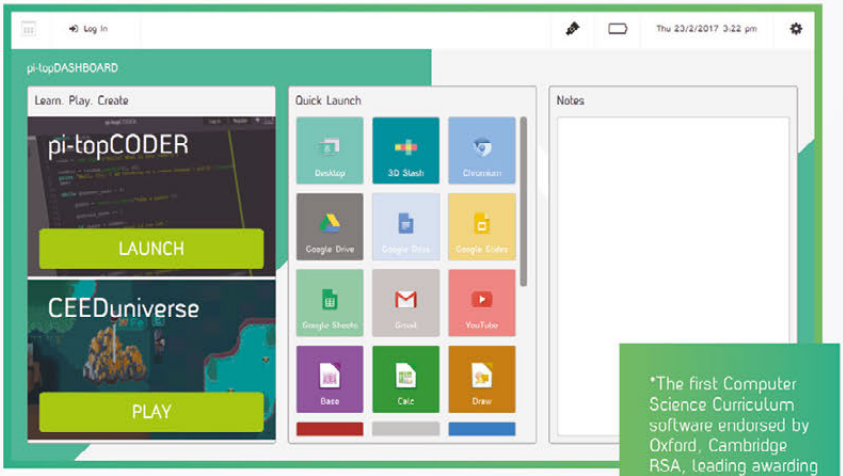
Color theme
Make the editor and your code look the way you love
Install keyboard shortcuts
Install the keyboard shortcuts of Vim, Sublime, Atom and others
Find and run all commands
Rapidly access and search commands from the Command Pale...
Keyboard shortcuts reference
A printable PDF with the most common keyboard shortcuts
Configure settings
Unlock the full power of VS Code by tweaking the settings
Interactive playground
Try essential editor features out in a short walkthrough

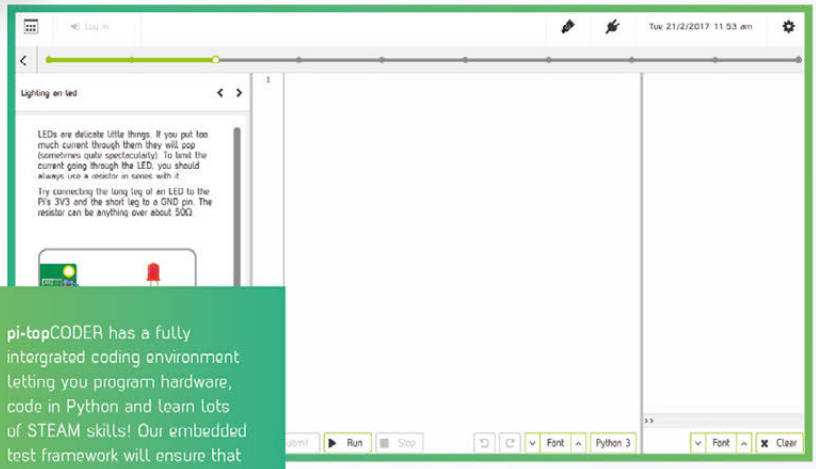
Above VS Code supports many programming languages in a user-friendly environment

pi-topOS

The OCR* endorsed **pi-top**OS (Operating system) platform comes pre-installed on the 8GB SD card shipped with every unit. **pi-top**OS software suite lets you - browse the web, - check emails, - create and edit Microsoft Office compatible files. It includes **pi-top**CODER and comes with the revolutionary educational game CEED**universe**.



*The first Computer Science Curriculum software endorsed by Oxford, Cambridge RSA, leading awarding body - **OCR**.



pi-topCODER has a fully intergrated coding environment letting you program hardware, code in Python and learn lots of STEAM skills! Our embedded test framework will ensure that you understand all concepts.

pi-topCODER

pi-topCODER is the interface that allows you to access worksheets and pre-built Raspberry Pi projects. It's the easiest way to tinker or deliver lessons by providing step-by-step guides for computer science and STEAM worksheets.

CEED**universe**

CEEDuniverse is our educational game. It's a world of fantasy developed in line with the computing curriculum – taking science fiction and transforming it science. It is a FREE massive role-play game carefully crafted by **pi-top**. The game teaches students to solve computational puzzles, how to code in Python and build physical circuits which interact with the game.

Exploring the planet, the students first encounter 'drag & drop' coding puzzles and move on to writing text based code.

MINIGAMES

Learn programing concepts through our minigames, for example learn problem decomposition by solving visual programming puzzles.

BT More power to you
CPC
Findel Education Resources The choice for schools for classrooms for specialists
MISCO
RS
ypo

pi-top

WWW.PI-TOP.COM

POWERED BY RASPBERRY PI

LEARN
PLAY
CREATE

pi-topCEED

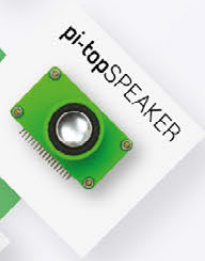
The modular all-in-one
Raspberry Pi powered desktop

- Adjustable Viewing Angles
- 14" HD Screen
- Modular Components

pi-top

The modular build-it-yourself
Raspberry Pi powered laptop

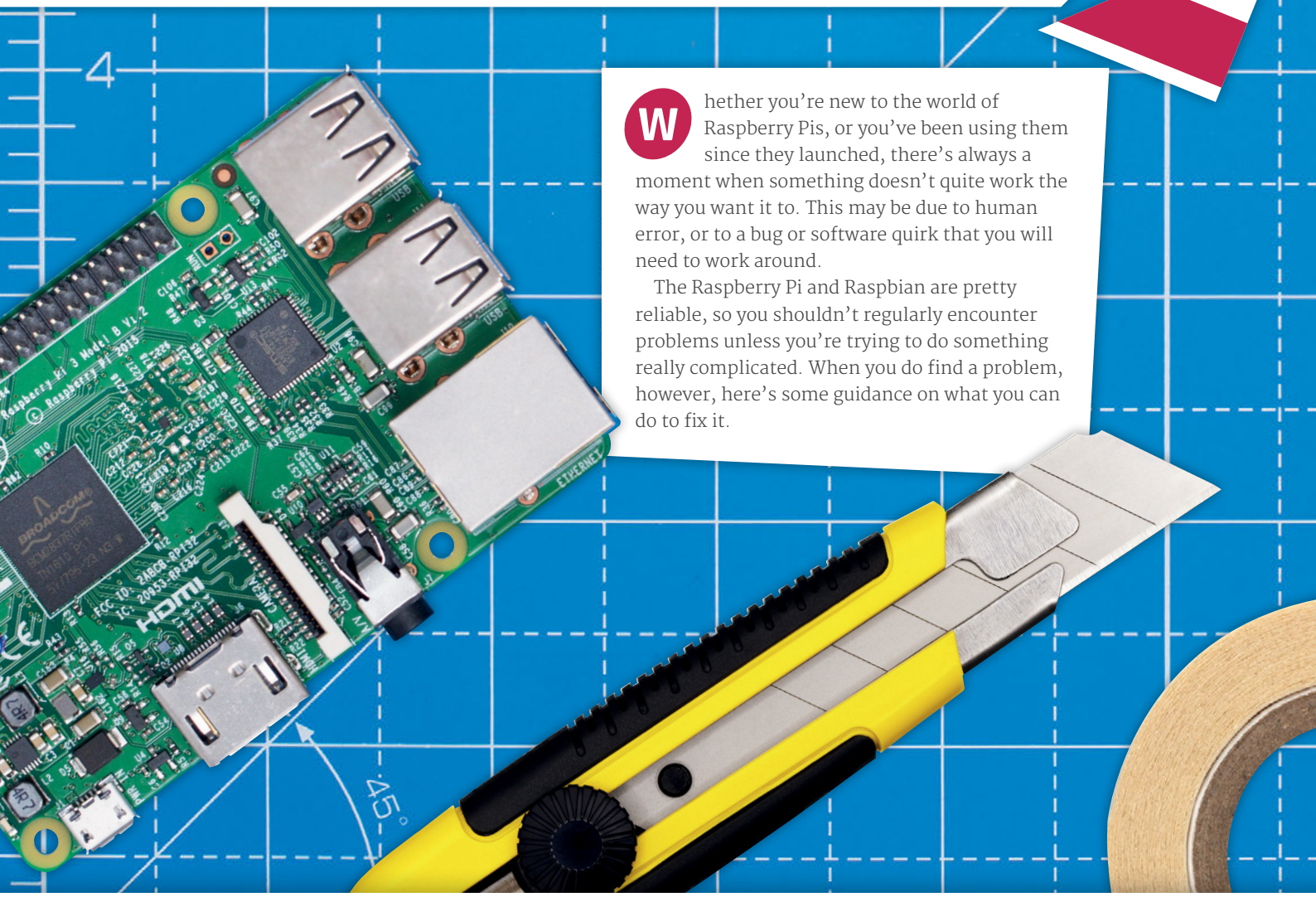
- 10 Hour Battery Life
- 13.3" HD Screen
- Modular Components



pi-top | Worldwide shipping available in green or grey at www.pi-top.com or our distributors
Stay up to date with our latest news by following our social media

RASPBERRY PI TROUBLESHOOTING SPECIAL

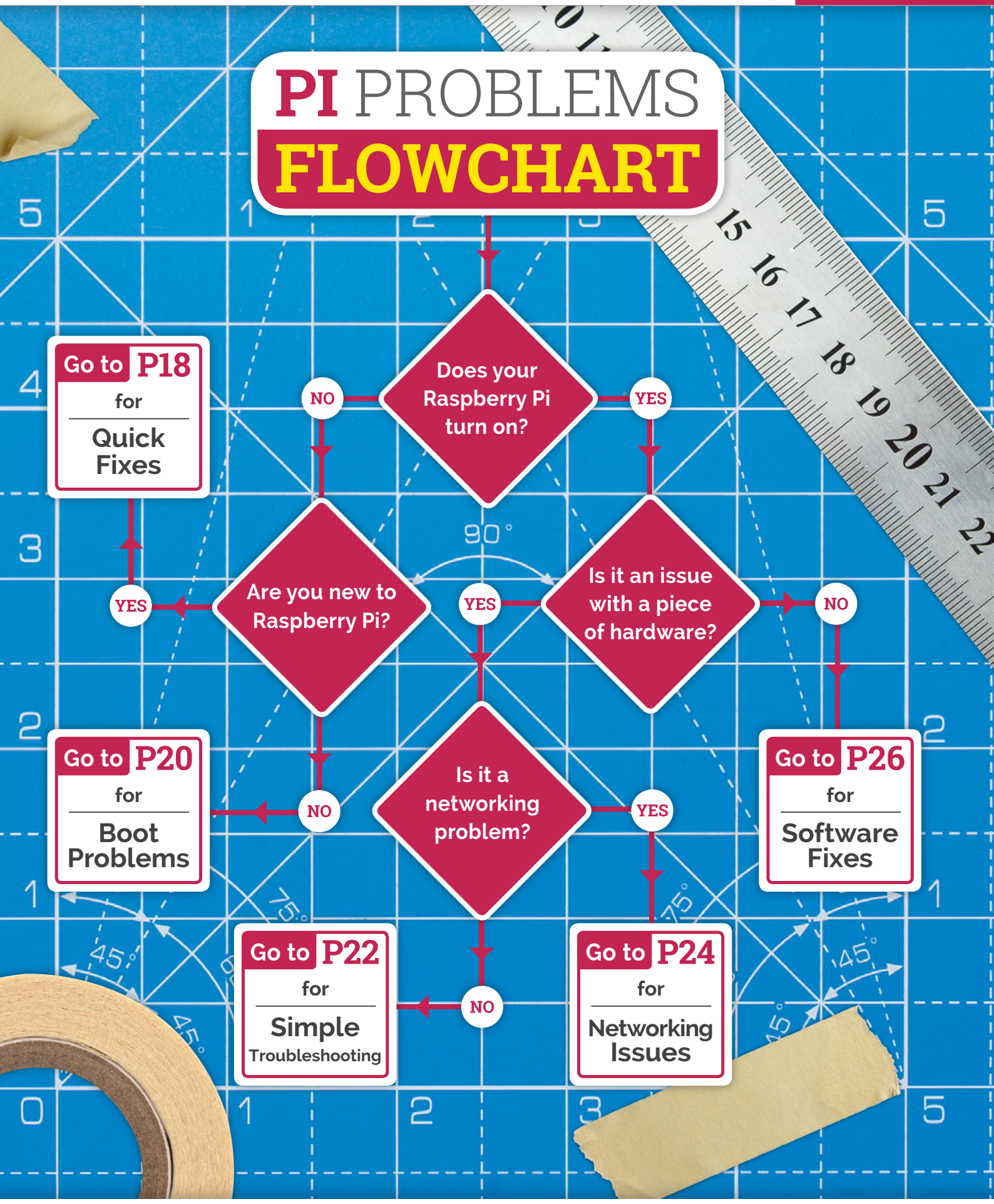
Is your Pi having problems? Troubleshoot it with our handy guide!



Whether you're new to the world of Raspberry Pis, or you've been using them since they launched, there's always a moment when something doesn't quite work the way you want it to. This may be due to human error, or to a bug or software quirk that you will need to work around.

The Raspberry Pi and Raspbian are pretty reliable, so you shouldn't regularly encounter problems unless you're trying to do something really complicated. When you do find a problem, however, here's some guidance on what you can do to fix it.

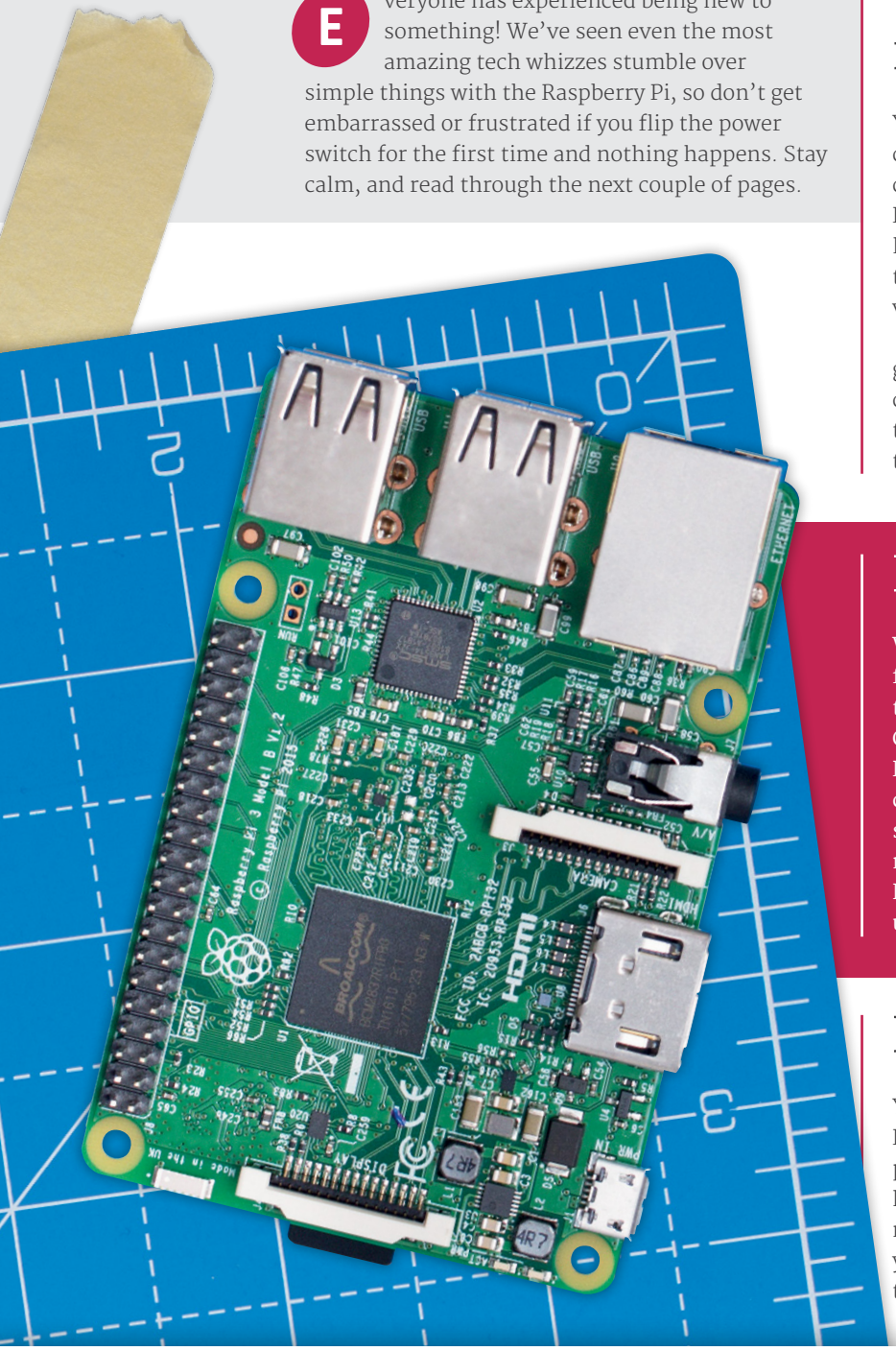
PI PROBLEMS FLOWCHART



QUICK FIXES

New to Raspberry Pi and having problems? Here's the stuff you need to know.

Everyone has experienced being new to something! We've seen even the most amazing tech whizzes stumble over simple things with the Raspberry Pi, so don't get embarrassed or frustrated if you flip the power switch for the first time and nothing happens. Stay calm, and read through the next couple of pages.



The Raspberry Pi is probably fine

Your first instinct may be that you've done everything correctly, so the Raspberry Pi must be at fault. We completely understand that reaction. However, each Raspberry Pi is tested once it leaves the production line. It definitely worked before it left the factory, and the chances of it turning up dead on arrival (DOA) are very slim.

Of course, in the unlikely case that you've gone through this entire article and come to the conclusion that your Raspberry Pi is faulty, contact the place you bought it from and they should be able to help you.

Essential accessories

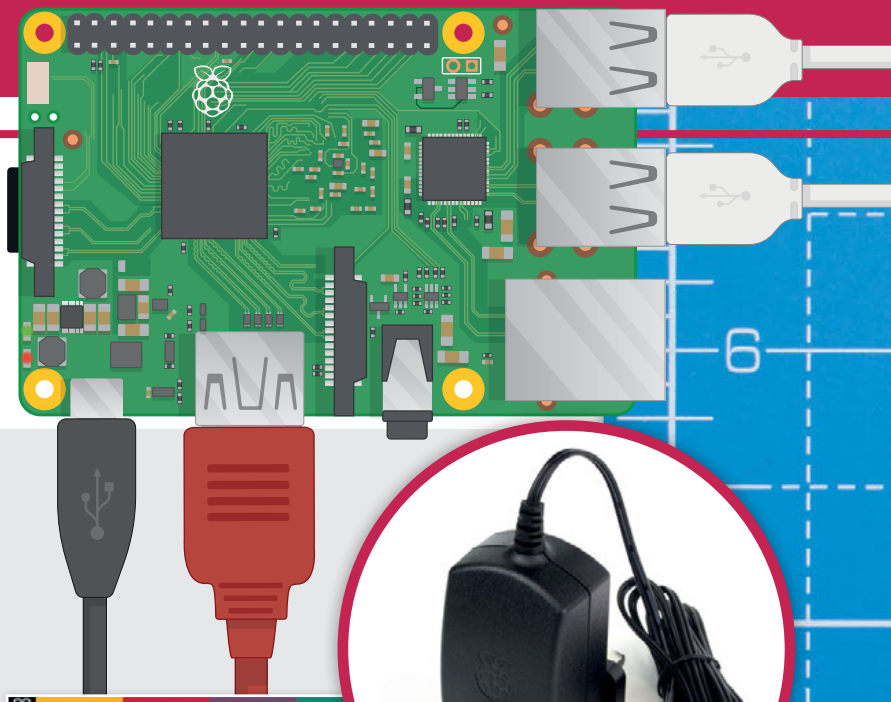
We've all done it: forgotten, or just missed the fact that our new gadget needed something else to go with it – like batteries for the toy you got at Christmas. You'll need two things to make sure your Raspberry Pi is working. The main one is a microSD card, which you need to load with an operating system (more details over the page). You will also need a monitor or TV to connect to the Pi via an HDMI cable, and a keyboard and mouse to use it properly.

Reusing SD cards

You've taken the SD card from an old Raspberry Pi that you haven't used for a couple of years and plugged it into a brand-spanking new Pi Zero W. Is it having trouble booting? It's more than likely you'll need to use a fresh SD card in your new computer. If you've forgotten how to install an SD card, look across the page for our quick guide.

THINGS TO CHECK

These should always be your first steps when troubleshooting



Check all the connections

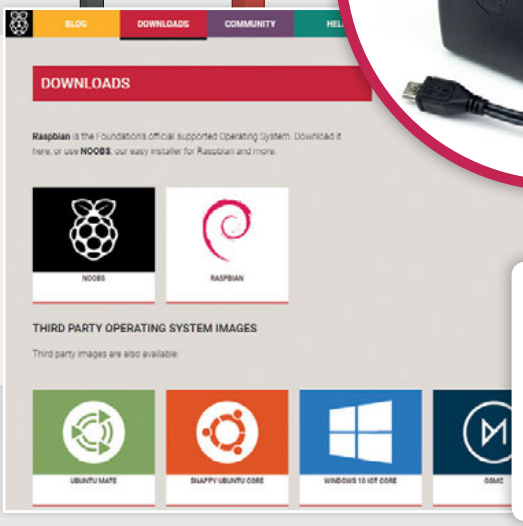
This may seem obvious, but it's always worth wiggling a few cables. You should pay close attention to the SD card: make sure it's pushed all the way in on a Raspberry Pi Zero or Pi 3, and properly clicked into place in an A+, B+, or Pi 2. The HDMI cable should also be checked at both ends.

Check the power

Are you using the correct power supply? Are you plugging it into the correct port on a Pi Zero? For a Raspberry Pi 3, a 2.5 A power supply is recommended, while other models can use the same, or a 2 A supply. Check that the power supply works on another device before giving up on your Pi.

Faulty OS

It's possible that the operating system wasn't installed properly on the SD card. The Pi might not boot up properly, or you might see a black screen when you turn it on. The green ACT LED near the power supply input (PWR IN) will blink rapidly if it is able to read the card. If reinstalling doesn't fix the problem, try downloading NOOBS or the OS image again. The OS can sometimes be corrupted during downloading.



Check the monitor

Just double-check it is turned on and set to the correct input. We've all been there – no judgement here.

Problem still not solved?

Turn the page for **Advanced Boot Troubleshooting**

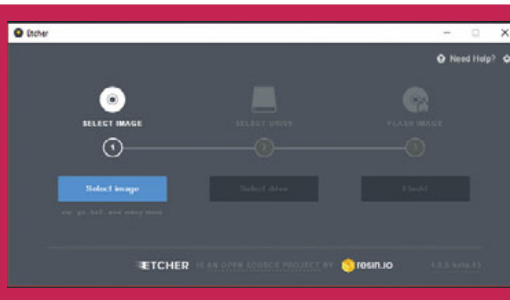
Best installing practices

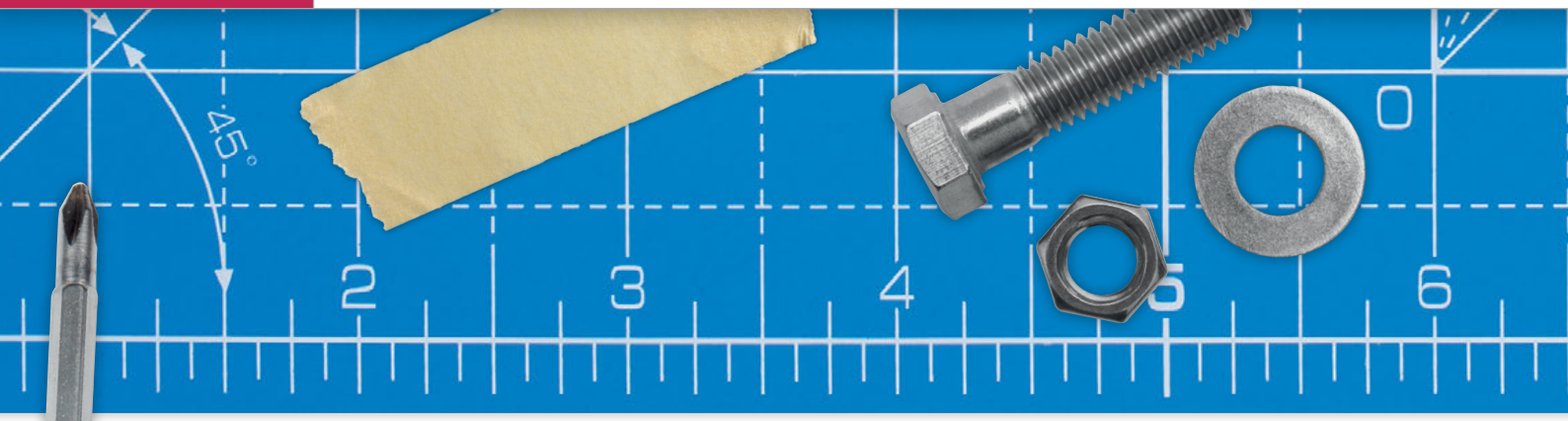
NOOBS

New Out Of the Box Software, or NOOBS, is a series of files designed to be saved on a blank SD card. Download the zip file to the card and extract everything. This makes sure that all the files you need on the SD card are there. Delete the original zip file, and put the card into your Raspberry Pi.

ETCHER

When installing Raspbian or any other OS on its own, you can always write the image directly to the SD card. Etcher is the best app for this, and we have an excellent video on how to use it here: **magpi.cc/2sj7leN**.





BOOT PROBLEMS

Raspberry Pi not turning on? Here are some things to look out for...

You could use a Raspberry Pi for years and not have any problems – until one day you can't turn it on, or it won't boot properly. There are plenty of reasons why this might happen, some of which we've talked about on the previous page. For more advanced problems, here are some tips and tricks to get your Pi powered up again.

Check the ACT LED

There's a green LED on the corner near the power supply input that blinks when the SD card is being accessed. It's labelled ACT, and it can be used to determine whether or not the SD card can be read. The LED should blink erratically when reading from the card during the boot process. If it's not blinking when the Pi is switched on, it means the card cannot be read.

Waiting on a blown fuse

If no power is being delivered to the Raspberry Pi and the fault isn't with the power supply, the polyfuse (resettable fuse) on the Pi may have blown – note that there isn't one on the Pi Zero. Unfortunately, the only solution to this is to wait a few days for it to reset. Trying to turn it on before it has recovered will probably blow the fuse again and reset the wait period.

Not enough power

The power LED will not light up if the voltage from the power supply drops below 4.65 volts. Check the power supply and replace it if you need a higher voltage.

Analogue video

The Raspberry Pi A+, B+, 2, and 3 can output an analogue composite video signal through the headphone jack. If it's your first time using this feature, make sure your cable works (see page 23). If you're using NOOBS, you can force it to change the video output during the first ten seconds of booting by pressing 3 for PAL/UK output, and 4 for NTSC video output.

Changing video outputs in NOOBS

NOOBS has four different video output options that you can change during the first ten seconds of booting. 1 is a normal HDMI output, 2 is safe HDMI, 3 is PAL composite, and 4 is NTSC composite. If you don't have a keyboard on the Pi, you can edit the **recovery.cmdline** file on the SD card from another computer and add **`display=X`**, where **`X`** is one of the listed options.

Updating an old card

Not all old Raspbian SD cards will work on newer Raspberry Pis, but you can try updating the OS using the older Raspberry Pi, then transfer the card to the new model. You can do this in the Terminal with:

```
sudo apt-get update
sudo apt-get upgrade
sudo apt-get dist-upgrade
sudo apt-get install raspberrypi-ui-mods
```

Correctly format the SD card

Make sure the SD card is completely formatted (not just a quick format), especially if you're using NOOBS. Remember, it should be formatted as FAT32.

Other SD card issues

SD cards don't last forever, so if a card is not working in your Pi, or on any other system, you may need to use a new SD card. Refer to the 'Making backups' boxout to see how to prepare for that eventuality. You should also make sure the SD card is properly connected to the pins in the slot on the Raspberry Pi – it can't be read it if it's not connected properly!

Pi Zero NOOBS

The Raspberry Pi Zero is only compatible with NOOBS 1.5 or later, while the Pi Zero W requires NOOBS 2.4 or later. Always make sure you download the latest copy of NOOBS.

Pi Zero workaround

Can't write over an old SD card? You can still try using it with the Pi Zero, but first you'll need to open a Terminal using a Pi that can read the card, and run `sudo rpi-update`. This will update the firmware and should set it up to work with the Pi Zero.

Light codes and advanced troubleshooting

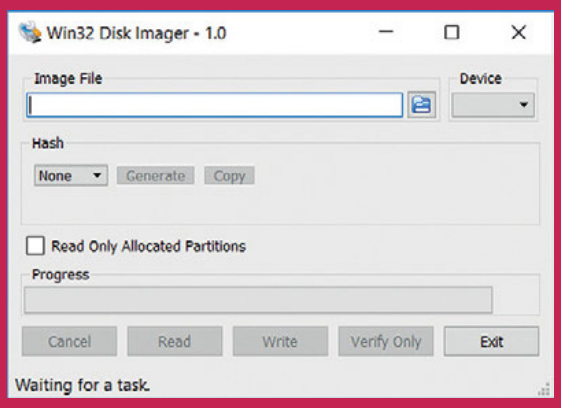
Earlier we talked about the ACT LED. It doesn't just show whether the SD card is being read – it may also output a pattern that looks like Morse code. These coded patterns will let you know about specific issues with the boot card. Check the additional information section of this forum post to find out what each code means: **magpi.cc/2sPvZWZ**.

CORRUPT CARD

Your Raspberry Pi's problem may not be with the software, but with the hardware: your SD card might be corrupt. This can happen for many reasons, but the two most common causes are turning the Pi off repeatedly without running a proper shutdown, or writing a lot of data to the card. The latter you'll only really experience in something like a server setup after a few years. The former can be avoided by using shutdown scripts, or using an OS that loads itself directly into the memory. Try piCore, a version of Tiny Core Linux: **magpi.cc/2ueA7UI**.

MAKING BACKUPS

Are you still unable to figure out how to boot up your Raspberry Pi? Are you sure it is a problem with the SD card? It pays to have a system for backing up your card so you can make a new one when you need to. You can use Win32 Disk Imager to make a copy or clone of your card, which you can then write to a different SD card. Check out our video on creating backups: **magpi.cc/MagPiYT.**



SIMPLE TROUBLESHOOTING

Solving common Raspberry Pi problems

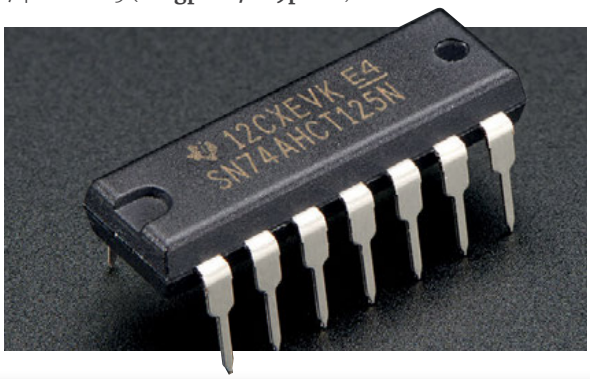
Sometimes, the Raspberry Pi doesn't work as you expect it to. The GPIO ports don't quite do what you are expecting, or a USB hard drive doesn't connect when you want it to. Here are some of the more common issues that users encounter on their Raspberry Pi journey.

Rainbows and lightning bolts

Seeing a rainbow block or lightning bolt in the top right-hand corner of your screen? This is the Raspberry Pi's way of telling you that it doesn't have enough power. Make sure your power supply can provide 2.5 A for a Raspberry Pi 3 and 2 A for any other Raspberry Pi model.

Components won't react to GPIO signals

The Raspberry Pi's GPIO pins output either 0 V or 3.3 V, providing a digital on/off signal. This is enough for most uses, but some components (LCDs, UARTS, and some NeoPixels) require a 5 V output. Most tutorials will let you know if this is going to be a problem, and help you to solve it. If not, you'll need to use a level-shifter chip in your circuit, such as the 74AHCT125 (**magpi.cc/2u9paTV**).



USB and Ethernet not working on a Model B+

If a keyboard or mouse doesn't work on a Raspberry Pi B+, and neither does a wired internet connection, it may be because you're using an old version of NOOBS. Make sure you download the latest version, or use version 1.3.8 or later.

Devices and drives (5)
Local Disk (C:)
91.8 GB free of 231 GB
Local Disk (D:)
395 GB free of 465 GB
DVD RW Drive (E:)
boot (F:)
41.2 MB free of 62.9 MB
Removable Disk (G:)

SD card backup not working

This usually occurs when you're trying to back up a card to another SD card of the same size, or smaller. Between cards that claim to be the same size, there will be slight variations that may cause problems. The best solution is to back up to a bigger card, or if you're handy with Linux, use GParted to shrink the main partition on the original SD card.

Lack of SD card space after an install

This will sometimes happen when you install the OS with NOOBS, but it's easy to fix. Go to Menu > Preferences > Raspberry Pi Configuration and choose Expand root partition to fill SD card. You'll need to reboot, but you should then have access to all your available space.

64+ GB SD card not working

The Raspberry Pi only recognises FAT32-formatted SD cards. Some formatting software for larger SD cards will use a different format (exFAT) that the Pi cannot recognise. You may need to change the partition to FAT32, and that can be done via Windows using this software: **magpi.cc/2uaRYM1**.

VGA adapter cable doesn't work

The Raspberry Pi HDMI output does not provide a signal that can be used with a simple HDMI to VGA cable. Instead, you will need a proper converter like this one: **magpi.cc/2u8WXg6**.

This example also comes with a 3.5 mm cable for the audio signal.

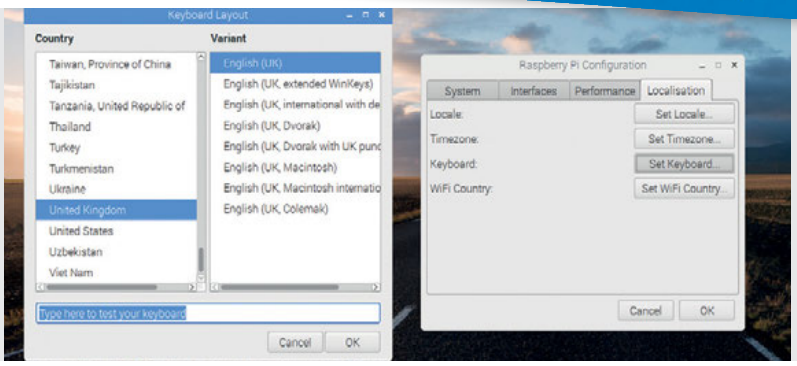
Raspberry Pi 3.5 mm AV socket wiring

Cable type	Sleeve	Ring 2	Ring 1	Tip	Works?
Raspberry Pi	Video	Ground	Right	Left	✔
MP3 player	Ground	Video	Right	Left	✖
Camcorder	Right	Ground	Video	Left	!
iPod AV Cable	Video	Ground	Right	Left	✔

! Swap yellow and red RCA cables

Keyboard outputs incorrect characters

Raspbian defaults to UK keyboard settings. It does try to figure out what kind of keyboard you're using, but it won't always get it right. To change the keyboard settings, go to Menu > Preferences > Raspberry Pi Configuration. You can then change the localisation settings, including the keyboard language.



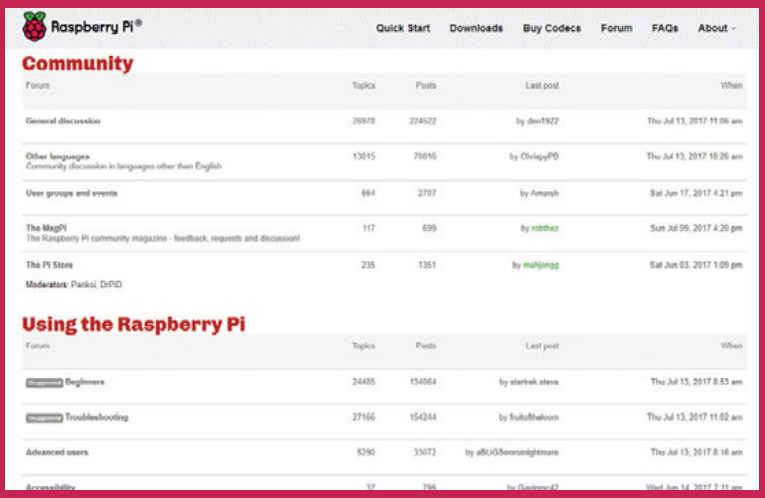
RCA composite video out of sync

Does the display on your TV resemble the output from a badly distorted VHS tape? This is usually a sign that the ground and video signals have been swapped over inside the monitor cable. If you made the cable, you may be able to fix this problem; if not, you'll need a new cable. Alternatively, if you're getting no video at all, you may just need to swap the yellow and red cables – see diagram, top right.

TAKE IT TO THE FORUMS

We've covered a lot of common issues in this feature, but not every problem will be here. If you can't find a solution to your problem, it's always best to head to the Raspberry Pi forums: **magpi.cc/1NlH5rQ**.

Before posting a question, you should always search the forum in case anyone else has experienced the same problem, and solved it. If not, drop a post in the most suitable place and the Pi community should give you a hand! They're great like that.



NETWORKING ISSUES

Get yourself back online with these tips for fixing your network connection

Access to the internet is essential for anyone using a computer. When you start having network problems and can't get to Google, stay calm. Troubleshooting your network might involve a very quick fix or an extremely complex solution, but most problems will have a simple cause. Here are some things to look out for.

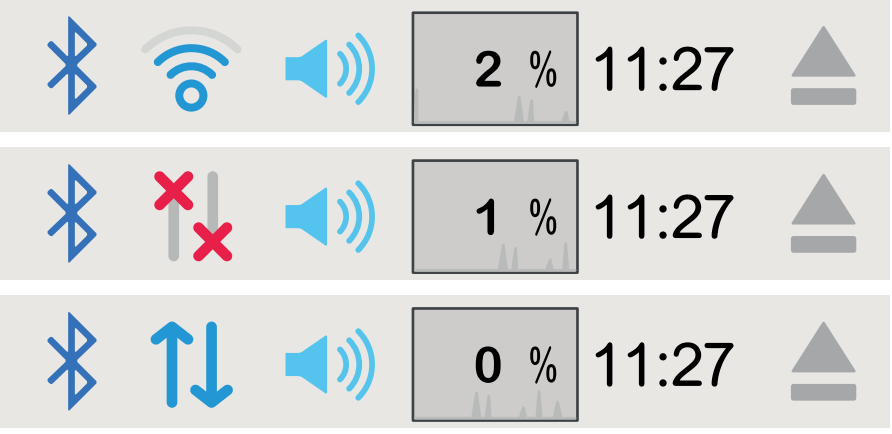
SIMPLE STEPS

In the Raspberry Pi desktop environment, you'll see a symbol near the top right-hand side that lets you know the status of the network connection. It will show two wires plugged together for a wired connection, or the standard wireless logo for wireless internet. If there's no network connection, you'll see the wires unplugged, along with a red X. If there's a network connection but no internet access, the Pi will still appear to be connected.

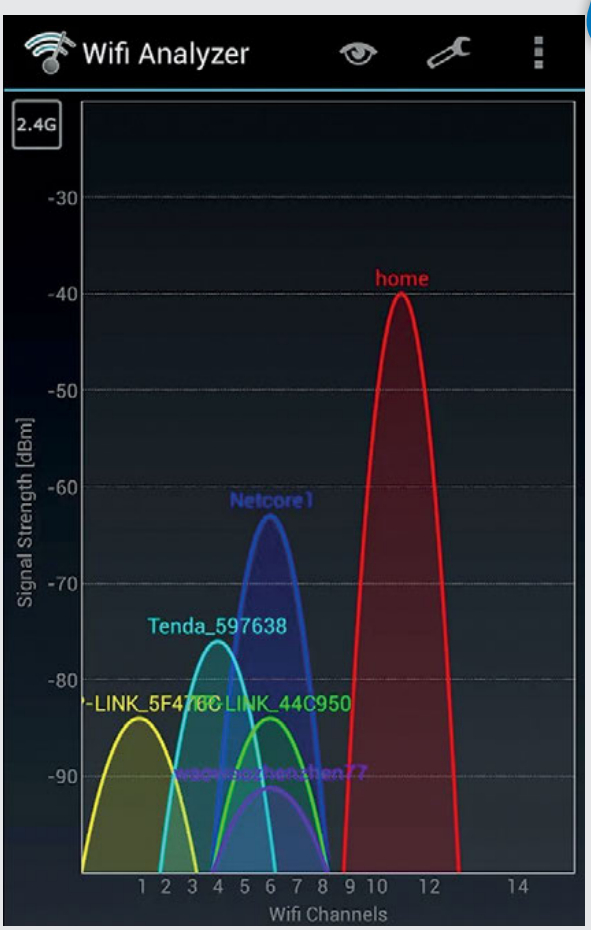
If you're using a wired connection, make sure the Ethernet connector is firmly pushed into the Raspberry Pi. A loose cable will not always touch the connectors.

If you're using wireless, double-check that you've entered the password correctly, and make sure you are trying to connect to the correct network. If you're using a WiFi dongle, make sure it is firmly pushed into the USB slot.

When a wired Ethernet connection is detected, the wireless LAN is disabled, so they cannot both be used at the same time



Always check the network connection indicator to figure out whether it's a network problem or an internet connection issue

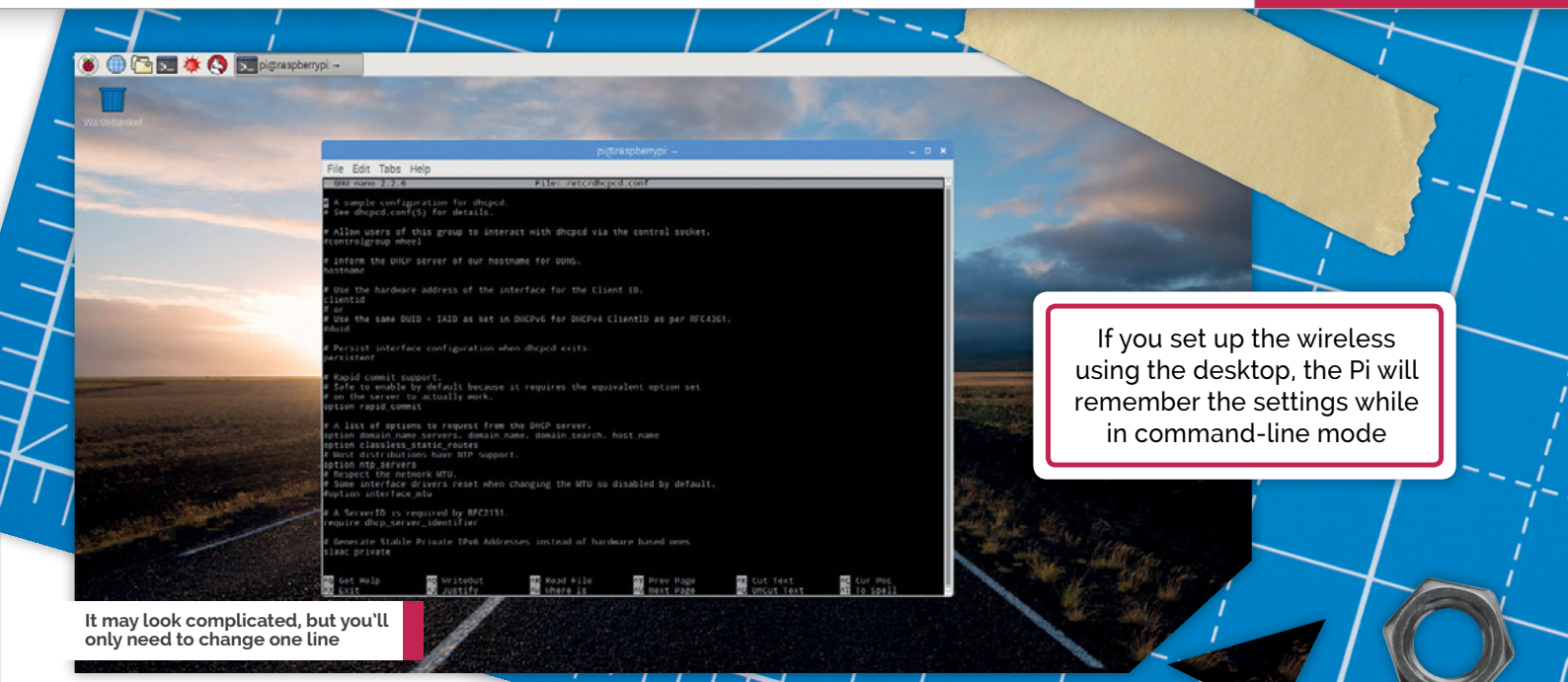


Use this app to find a good place to locate your Raspberry Pi

LOCATION, LOCATION

If your wireless internet is intermittent, you may need to re-evaluate your Pi's position relative to your router. Use a smartphone to determine the strength of your wireless network in different locations. On Android, you can use the Wifi Analyzer app: **magpi.cc/2ucqLbx.**

This app also shows the traffic on specific WiFi channels. You may find that changing your router's wireless channel will improve the signal quality.



It may look complicated, but you'll only need to change one line

If you set up the wireless using the desktop, the Pi will remember the settings while in command-line mode

THE RIGHT ADDRESS

If you're using an older Raspberry Pi, you may have set a static IP on the network interface. If your current network doesn't support that specific IP, it won't let your Raspberry Pi connect. Short of wiping the SD card and reinstalling Raspbian, the best solution is to change the settings so that the router assigns the IP address.

On older Raspbian installs, you'll need to edit the **/etc/network/interfaces** file and change the **`eth0`** and **`wlan0`** lines to be **`iface eth0 inet dhcp`** and **`iface wlan0 inet dhcp`** respectively.

On newer installs of Raspbian, the **/etc/dhcpcd.conf** file is the one to edit for wired connections. Change the relevant line to **`iface eth0 inet manual`**. For wireless connections, you'll need to look in **/etc/wpa_supplicant/wpa_supplicant.conf** and remove any lines that assign a fixed IP.

OFF THE PI

Sometimes the problem may lie with your network, rather than with the Pi itself. If you're using Ethernet, check all the connections to the modem or router. For wireless connections, make sure that other devices, such as smartphones, are able to connect to the WiFi.

If you have a network connection, try dialling into the main router by opening the browser and entering the IP address of the router. If you don't know the IP address, you can usually find it on the back of the router. From there, you can get an indication of what might be wrong. For example, you may find that there is no internet connection to the router, or that you need to reset the password.

If all else fails, reset the router by turning the power off at the wall for about 15 seconds.

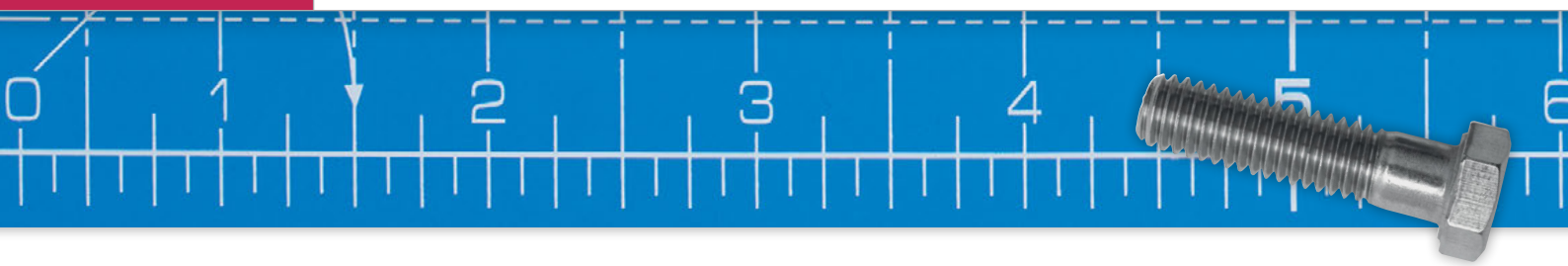
SSH is now turned off by default – you can turn it back on in **Menu > Preferences > Raspberry Pi Configuration**

To set up a wireless connection in the command line, follow this guide: **magpi.cc/2hQhwW4**

COMPATIBLE DONGLES

If you're using an older model Raspberry Pi, it won't have built-in wireless LAN like the Raspberry Pi 3 or Zero W. In that case, for wireless internet, you'll need a WiFi dongle. Not every WiFi dongle works on the Raspberry Pi, so if you have one lying around you'll need to check it against this handy list: **magpi.cc/1P2pwPH.**

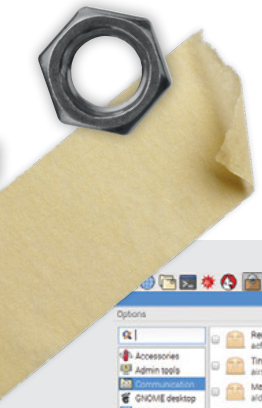
Otherwise, you can buy an official dongle here: **magpi.cc/2ckZADU.**



SOFTWARE FIXES

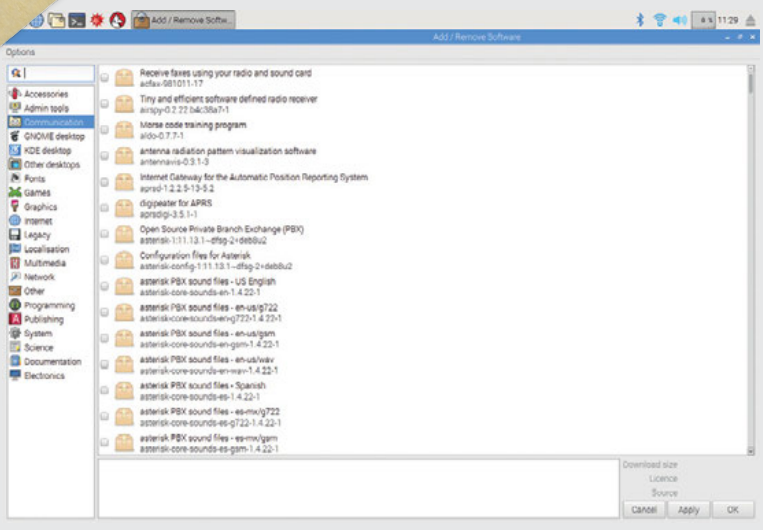
What do you do if software goes wrong? Follow our handy tips!

With all the different projects you could run on a Raspberry Pi, it's likely that you'll run into a hiccup with a piece of code, an app, or an installation. Here are some tips to get everything running smoothly again.



Installation issues

Installing software should be easy. Search for it in the graphical package manager, or install it using the Terminal. Sometimes the installation may not go as planned, so here are some tips for successful installing.



01: Update the software list

Raspbian can only install software if it knows that the software exists. The Pi should update its software list automatically when you open the graphical package manager, but you'll need to update the list yourself before installing software from the Terminal. Do this by running **`sudo apt-get update`**.

02: Try the Terminal

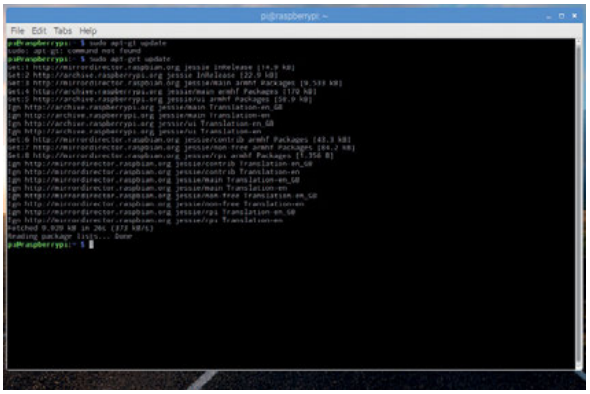
If you're having problems with the graphical package manager, it's a good idea to use the Terminal instead. It probably won't make it easier to install the software, but it should be easier to figure out what went wrong. To install software via the Terminal, use **`sudo apt-get install`** followed by the name of the package. You may need to check the correct name of the package online.

03: Missing dependencies

Sometimes a piece of software won't install because a vital component is missing from the software list. The error output at the end of an attempt to install software using the Terminal should give you a clue as to which component is missing. An internet search will help you to find the missing package, as well as instructions on how to install it.

04: Updating software

Tweaks and updates to software in Raspbian occur fairly regularly. If a program isn't working properly, you may need to update it. This can be done by updating the software list as described above, and then using **`sudo apt-get upgrade`**.



Code debugging

You've spent ages building your Python program, and now it won't work. We can't help with specific errors, but we do have some tips on how to track down problems.

01: Check syntax

Everyone forgets a colon or an apostrophe every now and then. Have a read through your code and make sure it all makes logical sense. If you press **F5** to run it in the IDLE shell, IDLE may highlight any weird bits of the code for you to look at. Don't forget to pay close attention to indents in your code.

02: Read the error message

If there's a problem with code you're running in IDLE, you will usually see an error message highlighting where and why the code went wrong. Google the exact wording of the error to track down the problem.

03: GPIO issues

If you cancel a program without giving the proper GPIO exit instruction, you may get some strange results next time you run the program. In the shell, type `GPIO.cleanup()`. To be extra safe, exit the IDLE shell and start it again.

04: Running at startup

Some projects need a script to be run at boot. Our favourite way of doing this is to edit the profile file using `sudo nano /etc/profile`. Add `python script.py &` at the bottom, replacing **script.py** with the location and name of your script. You can also turn off boot to desktop if you need to.

QUICK ANSWERS

Q: Is Adobe Flash available on Raspberry Pi?
A: Yes, via the Chromium browser.

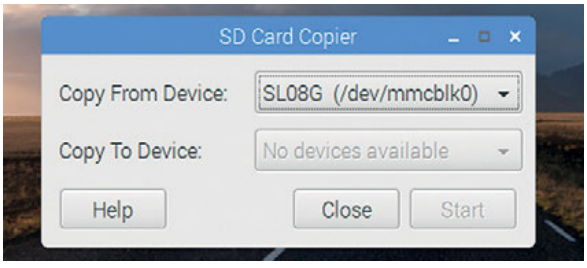
Q: Help! I can't type a password when it asks for it!
A: The Terminal won't show your password in asterisks as you type, but it's still being entered. Press ENTER to complete the password entry.

Q: How can I turn the screensaver off?
Q: This is not straightforward, but there's a forum thread that explains the process: **magpi.cc/2uc3zKP**.

Q: The zip file I downloaded doesn't work.
A: First, try downloading it again. If that doesn't solve the problem, install **7-zip** and use that to unzip the file.

Rolling back

We've seen problems caused when new software on Raspbian negatively affects other software. The best solution for this is to keep regular backups of your SD card. Back up a version of the card that you know will work, so that you can reinstall it if you need to. Otherwise, try carefully removing the new software using `sudo apt-get remove`.



BEYOND THE PI FORUMS

Sometimes a problem may not be caused by the Raspberry Pi, but by the software you're using. In this case, always check to see whether there is a specific forum for this piece of software. If not, try general help websites such as Stack Overflow (**stackoverflow.com**), which is full of veteran developers and computer users who can usually help you figure out a solution.

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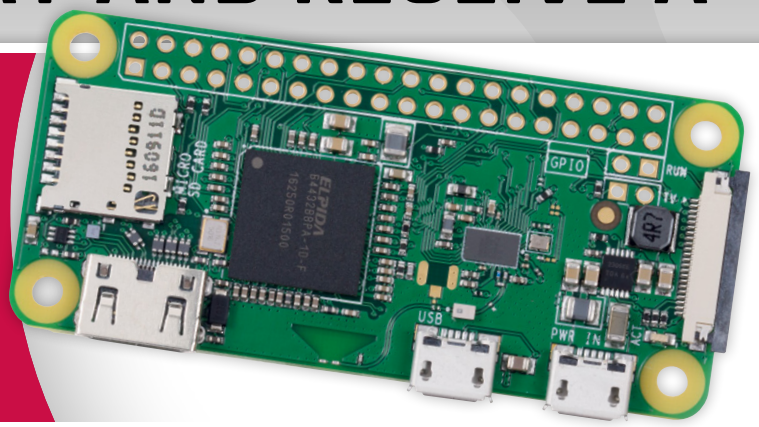

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JACK BARKER

Jack is based in Melbourne, Australia. By day he works as a business analyst; by night he writes code, blogs, and muses on all things technology.
jackbarker.com.au

PHOTO BOOTH

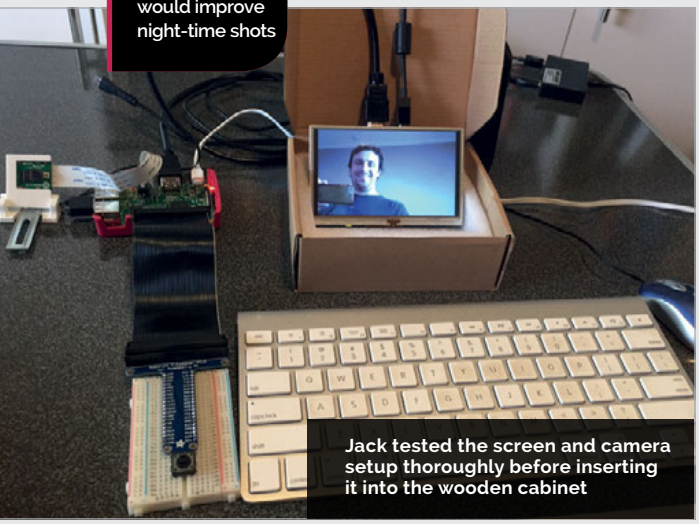
Need a wedding photo booth? You could always build your own...

Quick Facts

- Build details are on Jack's blog (**magpi.cc/2s07JZo**)
- The booth took 20 hours to make
- By default it takes four photos per session
- Live internet backup of photos is possible with a WiFi connection
- External lights would improve night-time shots

As first Raspberry Pi projects go, building a photo booth for your own wedding is an ambitious and potentially stressful one, but that's just what Jack Barker did for his and fiancée Pam's big day. "I've always been fascinated with tinkering and programming but, in truth, the primary motivation came when I saw how much it cost to hire a photo booth!" After getting quotes upwards of A$500 (£300), and struggling to stay within their wedding budget, Jack realised he could build his own booth for considerably less money.

"When I first mentioned the idea to Pam, she was a bit nervous that it might be another project that wouldn't eventuate!" admits Jack. The booth took him 20 hours to complete, spread across a number of weekends.



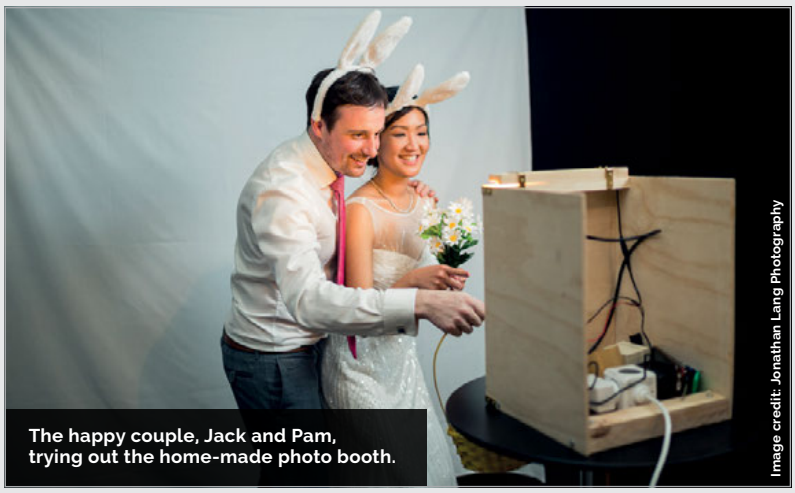
Jack tested the screen and camera setup thoroughly before inserting it into the wooden cabinet

> "As the wedding date drew closer, Jack had to de-scope some ideas that weren't absolutely essential"

This included writing all the code from scratch – available on his GitHub page (**magpi.cc/2sNsRic**). "Certainly a lot of that time was spent trying out different ideas, and deciding on which features to include." As the wedding date drew closer, Jack had to de-scope some ideas that weren't absolutely essential, including a printer to produce instant copies of the photos.

Since the venue had no WiFi connection, Jack's plan to run a live backup of photos to the internet also had to be shelved. "My low-tech solution was to simply write the images to the Pi's SD card (and hope for the best). The following day I was very glad to see that they had all been saved without issue, and I was then able to post them online for the guests to view."

Building the main booth structure from plywood, Jack cut out a section for the LCD screen and drilled holes for a large arcade button below and the Raspberry Pi Camera Module above. Jack used a 3D-printed part to align the



The happy couple, Jack and Pam, trying out the home-made photo booth.

Image credit: Jonathan Lang Photography

Light from a strip of ultra-bright LEDs is diffused by an angled piece of wood
The LCD screen gives instructions and then a live view of the guests to aid positioning
Guests press the large arcade button to start a new photo session

camera perfectly with the hole, but he says this is optional. The Pi itself was also taped to the rear of the front panel. For improved lighting of indoor shots, Jack placed a strip of white LEDs across the top, later adding a simple light diffuser using an angled piece of wood.

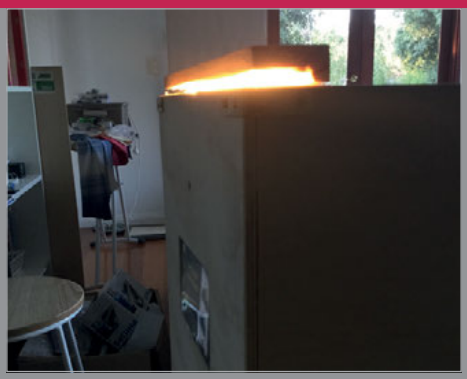
Jack set up the Python software so that when a guest presses the button, a seven-second countdown is started. "During the first four seconds of the countdown, an instructional slide is shown ('Get ready for photo 1'). For the final moments of the countdown, the participants can see themselves live on the screen and they can also see the timer counting down. This helps the participants to position themselves in front of the shot, before the photo image is taken." Once the first photo is taken, the cycle repeats to capture a total of four images.

So, how did it work out on the big day? "The guests were impressed that I'd been able to build it myself," says Jack. "It served as a great topic of conversation, and helped get some of the guests mingling. Oh, and yes, there has been interest from people asking to borrow it."

BUILD A PHOTO BOOTH

>STEP-01
Wooden cabinet

Jack used pieces of plywood joined with brass brackets to make the photo booth's cabinet, sawing out a carefully measured section of the front panel to fit the LCD screen.



>STEP-02
LED light diffuser

An angled piece of wood is used to diffuse the light from a strip of white LEDs. Rather than acting as a flash, Jack opted to keep the LEDs turned on, which avoided tricky timing issues.

>STEP-03
Wire it up

Currently, Jack is using three separate power sources – one each for the Pi, LCD screen, and LEDs. However, he's looking to switch over to a dual rail power supply (5 V plus 12 V) soon.

STEVE UPTON

His parents would say he was breaker, but today he's more of a maker. Founder of Makespace (Cambridge) and creator of lots of amazing projects.
ste5eu.com / twitter.com/ste5eu

PI BASH

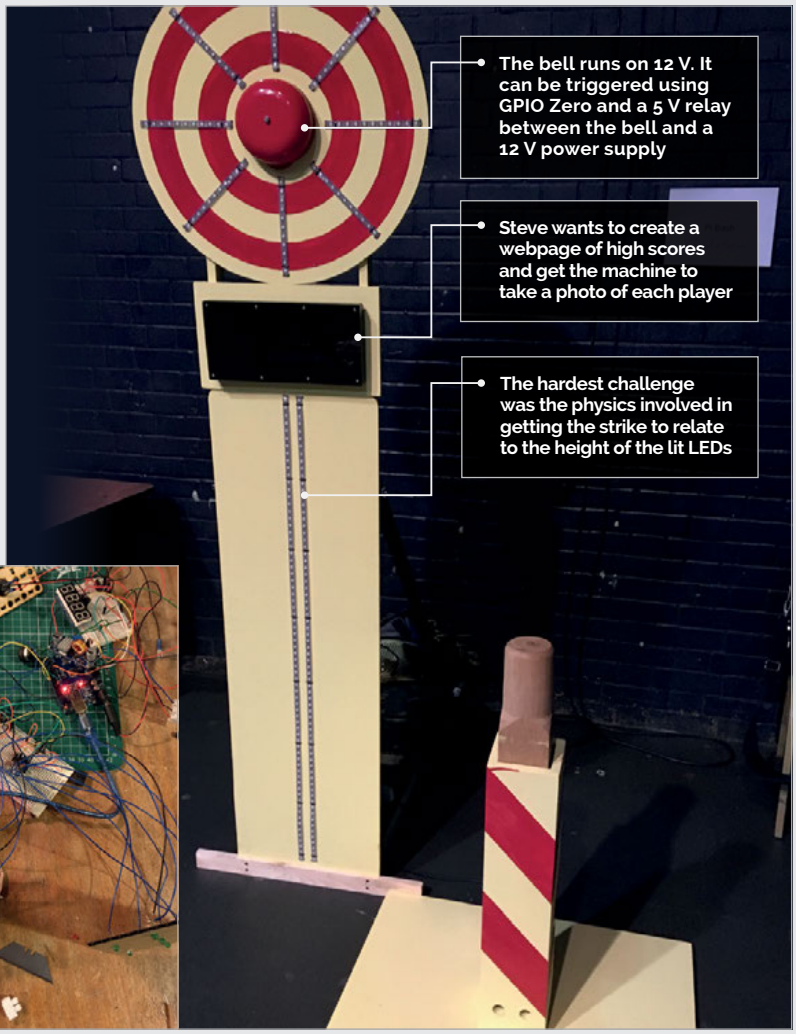
When Steve Upton was challenged to have a bash at creating a Hi Striker machine, he hit the ground running and ended up developing two

Quick Facts

- It took Steve 24 hours to make
- It cost £174 in parts from RS, Pi Hut, and Pimoroni
- The current highest scorer is a blacksmith
- The frame was designed using Autodesk's Fusion 360
- A refined version will be ready for a Maker Faire in October

If you've ever been to a fairground and been asked to 'step right up' and 'test your strength', then you may have found yourself smashing a hammer against a puck in an attempt to ring a bell. These so-called Hi Striker attractions have been popular for close to 100 years, but when Steve Upton based one around an Arduino, he didn't realise he'd soon have a Pi-based hit on his hands.

The idea for building the gaming machine came from a company called AJW Distribution, which had approached the members of Cambridge's inventing shed, Makespace. The firm wanted something to entice people to its stand at a forthcoming trade show. "They wanted it to look like the side of a building, and use their cladding and roofing material," says Steve, who agreed to the challenge.


The bell runs on 12 V. It can be triggered using GPIO Zero and a 5 V relay between the bell and a 12 V power supply
Steve wants to create a webpage of high scores and get the machine to take a photo of each player
The hardest challenge was the physics involved in getting the strike to relate to the height of the lit LEDs

Below Steve built a full working version, adding an element at a time. This image is an early prototype

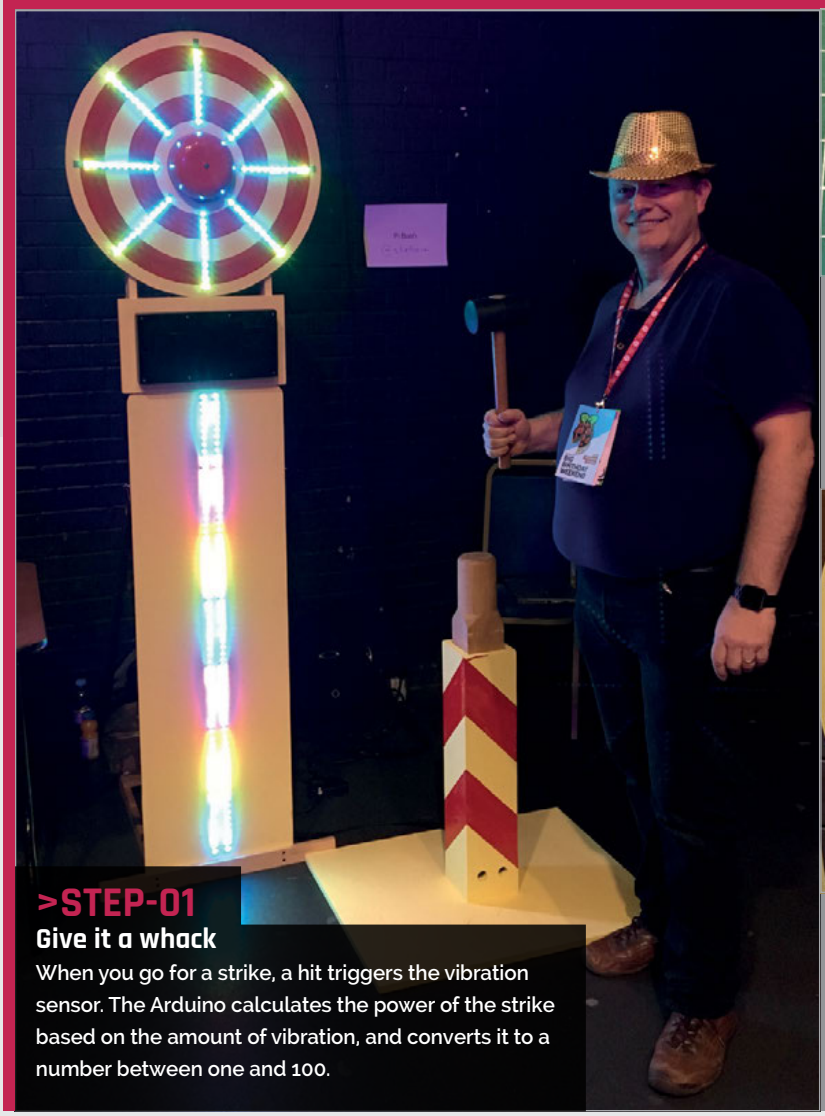
New and improved

Having created the machine, which made lots of cash for charity, Steve decided to play around with his design. "I knew it would be great for Raspberry Pi parties, Jams, and Maker Faires," he says. "So I just had to create another improved version based on what I'd learnt." He was going to call it Pi Striker, "but I couldn't write an 'r' with the displays I intended to use for the scoreboard." Instead, he named the new project Pi Bash and, grabbing a wad of paper, began to draw up his plans.

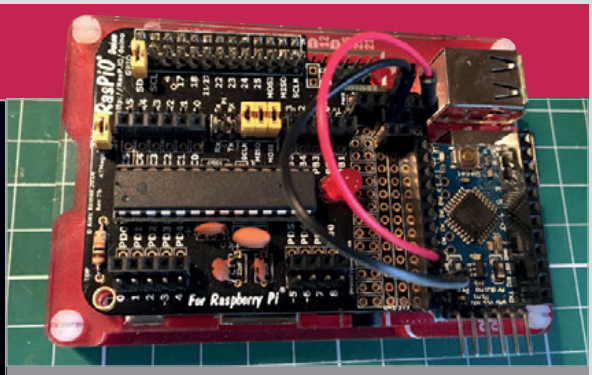
Steve knew what he needed to create the machine based on his previous experience. He decided to use the small, inexpensive plug-on RasPiO Duino board for sensing and the focused monitoring of speed. He also used a pressure sensor which could detect a hit, a vertical LED strip that would light up according to how hard the impact was, some star-shaped LED strips, and a bell with a relay controller to produce a satisfying ding if the player was successful.

He also wanted a mode selector so that the game could be

FAIRGROUND ATTRACTION



>STEP-01
Give it a whack
When you go for a strike, a hit triggers the vibration sensor. The Arduino calculates the power of the strike based on the amount of vibration, and converts it to a number between one and 100.



>STEP-02
Lighting the way
The information is sent to the Raspberry Pi, which loops and counts up to this value. It triggers updates to the LED strip and the scoreboard via a GPIO port.

>STEP-03
Ring that bell
If the measured power is enough to reach the top, the relay is triggered, again via a GPIO port. It connects the 12 volts to the bell, which then rings. Success!

adjusted to suit the player; a reset button; and the aforementioned scoreboard. "Once I had all of these working individually, I built the wooden support structure and started to add them together," recalls Steve. "I could then tune the sensing calculations to make it feel as realistic as possible." There wasn't much programming involved, although the sensing code, written in C, was fairly complex.

What are the scores?

The scoreboard was tricky to make. Rather than using a screen, Steve wanted to use three large seven-segment LEDs to make the score clear, "but I couldn't find anything appropriate for sale, so I built one myself." The seven-segment displays were connected to a laser-cut Perspex mount which Steve built at Makespace.

> "I've got a couple of sensitivity settings so parents and youngsters can compete on a more equal footing"

"I bought the LEDs online, along with the components to build controllers for them," he adds, referring to the resistors, shift registers, optocouplers, and connecting wire. "This was one of the more challenging parts of the project." The lights and sensors also proved tricky to control, so they remain connected to the Arduino at the moment.

More difficult, though, is actually achieving a high score, but the reaction to the Pi Bash has been great. "I've got a couple of sensitivity settings so parents and youngsters can compete on a more equal footing. We had a lot of laughs at the Pi Birthday Party earlier this year."

CHRIS RIEBSCHLAGER

Chris Riebschlager works as Lead Software Developer at Dimensional Innovations, Kansas City, USA.
magpi.cc/2u887BS

THE PLAYABLE 12-FOOT ELECTRIC GUITAR

Asked to create 'something amazing' for the entrance of Boulevardia, a two-day music festival, the team at Dimensional Innovations didn't disappoint

Quick Facts

- The build took five weeks in total
- The body is constructed using layers of MDF
- Stickers were printed on 3M Controltac
- It uses HDMI for sound
- Watch the build process at **magpi.cc/2udZo0z**

Boulevardia is Kansas City's two-day music, food and beer event, this year drawing crowds to the historic Stockyards District. When tasked with making something 'amazing' to be situated just inside the entrance to the event, the team at design firm Dimensional Innovations "wanted to create something iconic, interactive, and engaging."

Although the idea of a 12 ft (3.6 m) tall electric guitar wasn't the first concept to grace their ideas board, it was the one that stuck. And soon afterwards, the team got to work designing both the internal electronics and external aesthetic of the build.

"Honestly, I didn't know if we would be able to make this happen," explains Chris Riebschlager, Lead Software Developer at Dimensional Innovations, "but I was smitten with the idea, so I pitched it to the team." Once the idea was green-lighted, Chris finally had an excuse to use the Bare Conductive capacitive touch board he'd been coveting as a maker, and they got to work on a prototype.

Prototyping

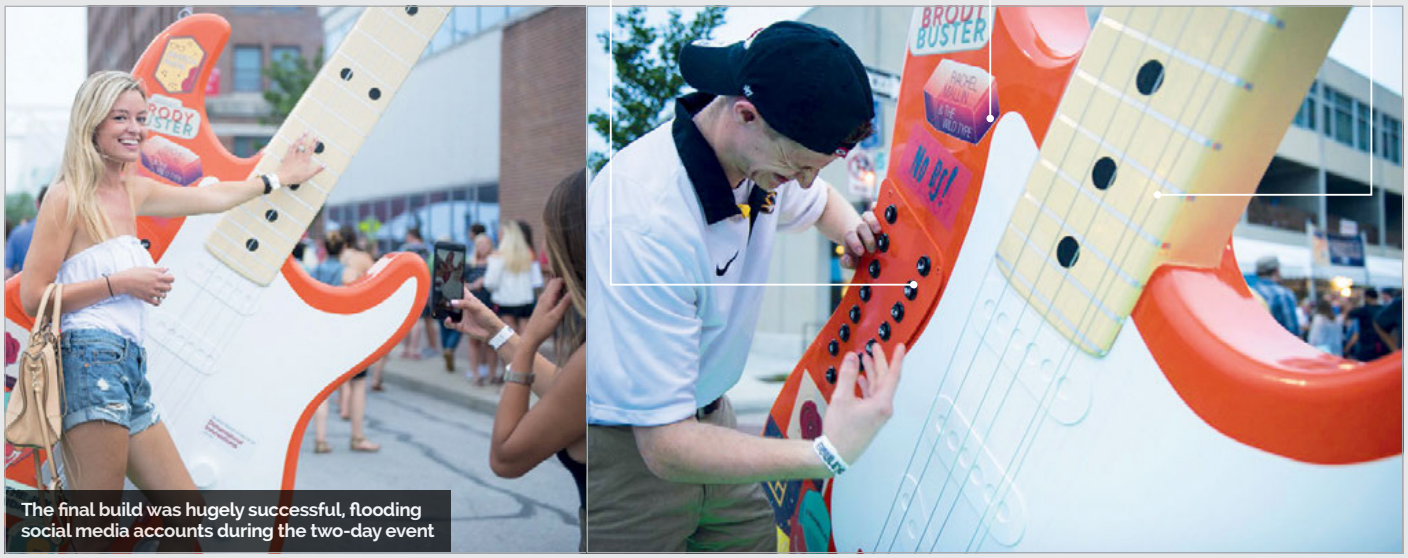
The plan was to use 16-gauge galvanised wire as the conductive material connected to the board, allowing the team to assign a WAV sound file to each wire. 'Strum' a wire and the board would register the connection and task the Raspberry Pi with playing back a specific note. A simple enough idea, and one we've seen countless times using fruit and tin foil – but for a 12-foot guitar, there was a little more work to be done.

Chris originally attempted to source his guitar note WAV files

Arcade buttons connected to GPIO pins are used to select chords, and choose a clean or dirty sound

Stickers designed and printed in-house represent the breweries and bands taking part in the Boulevardia event

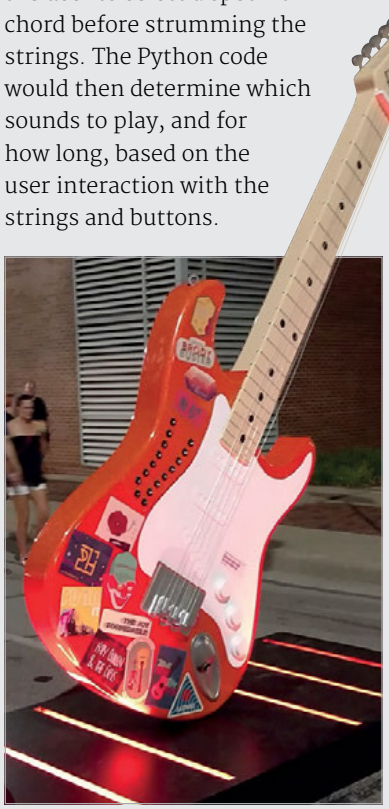
16-gauge galvanised strings connect to a Raspberry Pi via a Bare Conductive capacitive touch board



The final build was hugely successful, flooding social media accounts during the two-day event

Everyone worked together to create a realistic-looking guitar, utilising all the talents of the Dimensional Innovations team

from an electric guitar, but finding the sound to be "inconsistent and weird", he decided to instead take the pre-existing sound files from GarageBand. Still not content with the prototype, the team moved on to incorporating arcade buttons linked to the GPIO pins, allowing the user to select a specific chord before strumming the strings. The Python code would then determine which sounds to play, and for how long, based on the user interaction with the strings and buttons.



Building the body

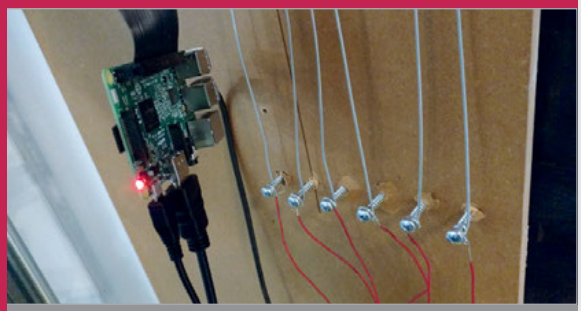
Turning to the design team for help with the guitar body, the team created an authentic-looking set of stickers, each depicting breweries and bands taking part in the event. These were then printed for inclusion on the MDF and steel body of the instrument, all put together in-house by the awesome engineering team.

> "One of the most exciting, challenging, and rewarding projects I've been a part of"

The final piece was installed inside the entrance to Boulevardia, and received overwhelming reactions from all attendees to the event. "This project was without a doubt one of the most exciting, challenging, and rewarding projects I've been a part of," continues Chris on his blog entry for the build. "From concept to execution, the entire project took only five weeks. The fact that we pulled this off in so little time really speaks to the talent and dedication of the people I get to work with."

If you happen to be in Kansas City, you can visit the guitar at the Dimensional Innovations shop, where it sits proudly on display for visitors to play – a constant reminder of what can be achieved with a little hard work and a great team.

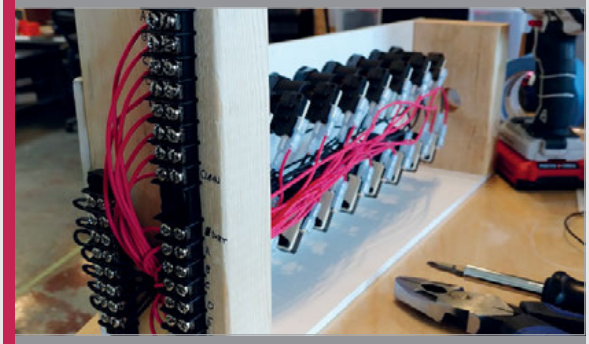
A GIANT IN THE MUSIC INDUSTRY



>STEP-01

Strings

A Bare Conductive board recognises capacitive touch via 16-gauge galvanised wires running down the body of the guitar. Each touch triggers the playback of a specific WAV file.



>STEP-02

Sound

Arcade buttons connected to the GPIO pins allow users to select different chords as they play. They also allow the guitar chords to sound 'dirty' or 'clean', depending on how rock 'n' roll the user wishes to sound.

>STEP-03

Body

The body of the guitar is built from steel and MDF, the latter shaped by the engineering team at Dimensional Innovations using a CNC router. Stickers representing performers and other participants in the event adorn the completed orange body.

UTTAM GRANDHI

An Elastic Mind enthusiast based in Brooklyn, NY. His interests span electronics, sculpture, biology, maths, animation, and origami.
utt.am/about

It was important to get the viewing angle, screen brightness, and orientation right for each screen
By mixing the Pi-powered screens with static mini-billboards, a busy, realistic-looking Times Square emerged
The cabling is tucked away and hidden behind the screens to make for a tidy installation

GULLIVER'S GATE

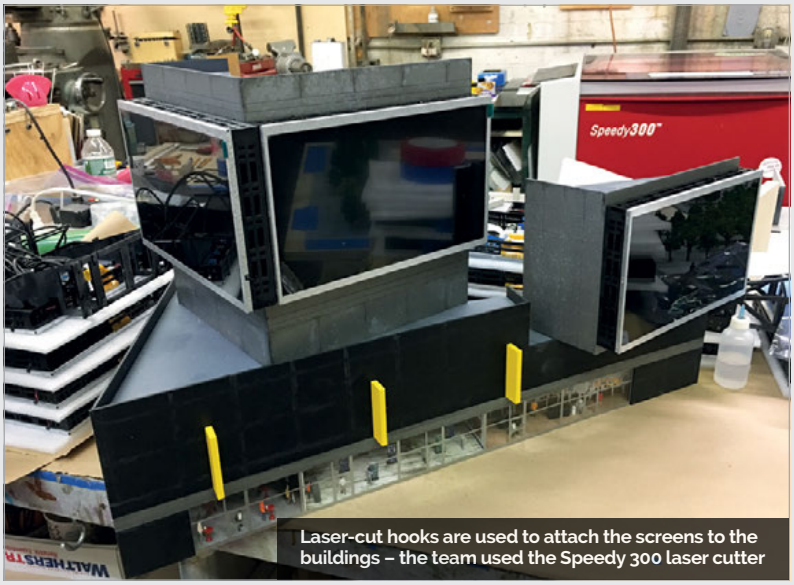
When recreating Times Square in miniature, Uttam Grandhi and his team knew the bright lights of its billboards would have giant appeal

Quick Facts

- Gulliver's Gate is inspired by the satire *Gulliver's Travels*
- It features landmarks from more than 100 cities
- Visitors use telescopes to see the detail close up
- The Pis are connected to a 24-port Netgear switch
- The team also bought a Raspberry Pi starter kit

Visit New York and it's hard not to be overwhelmed by the glittering scale of Times Square. Spread over millions of square feet, flanked by skyscrapers and assaulting the eyes with brightly lit advertisement hoardings, it is one of the world's most visited tourist attractions.

While the owner of the globe's largest and most expensive digital billboard once declared, "size matters in Times Square," one company, Gulliver's Gate, is proving that small can be equally beautiful. It has spent $40 million bringing together 50 nations in a 49,000 sq ft (4,552 m²) miniature world, situated in the former New York Times building on 44th Street. What's more, it has made great use of 23 Raspberry Pi Zeros.



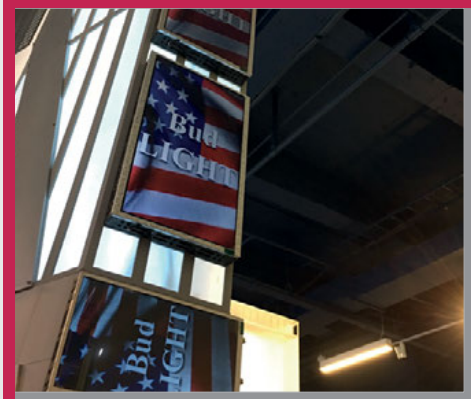
Laser-cut hooks are used to attach the screens to the buildings – the team used the Speedy 300 laser cutter

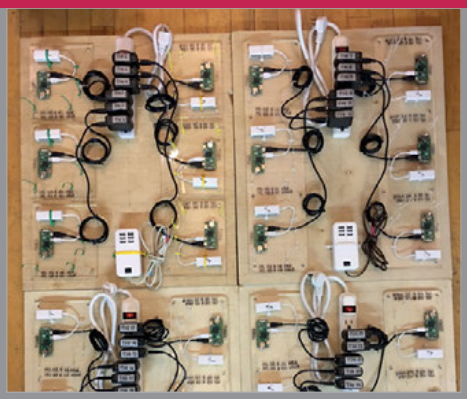
Pi-powered models

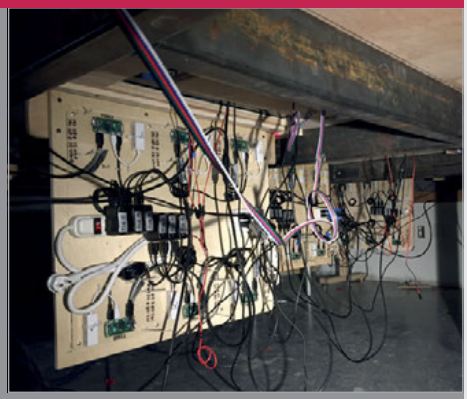
By connecting the Pis to 23 ten-inch and seven-inch screens, artist and design technologist Uttam Grandhi, together with a talented team from Brooklyn Model Works, has brought a 1:87 scale recreation of Times Square to life. They have used the displays (which were bought, complete with LCD control boards, from the electrical retailer **Banggood.com**) as small-factor digital billboards, fixing them to both the façades and terraces of the recreated towers.

"We've situated them on different miniature buildings and in different orientations," Uttam says, having used them in both landscape and portrait mode. "Our designer, Martin Eisler, had to design a modular

LIGHTING UP A MINIATURE TIMES SQUARE







>STEP-01
Managing the screens
The screens were used in portrait and landscape modes. Based on their power draw, the displays were distributed between different power supplies situated at the back of the hub plates.

>STEP-02
Connecting the Pis
The 23 Pis are installed across four hub plates, with varying lengths of power and HDMI cables running between the Pis and the screens. The displays are configured to use HDMI by default.

>STEP-03
Shining a light
Testing the screens is difficult because the Pis are under the platform – one person troubleshoots the Pis while another checks the displays. The adverts run via Adafruit's Raspberry Pi Video Looper.

mounting mechanism for the frames based on the Banggood screen dimensions. The frame parts were cut in 1/8-inch black cast acrylic and they were sanded and glued together with Acrifix solvent cement."

Construction and power

To fix the screen controllers to the displays, the team marked the mounting holes before drilling and taping them. "We only used three holes to mount the controller board because its base is not flat, and tightening all four screws would have tilted it to one side," explains Uttam. "The screens were attached to the frames using clear VHB tape."

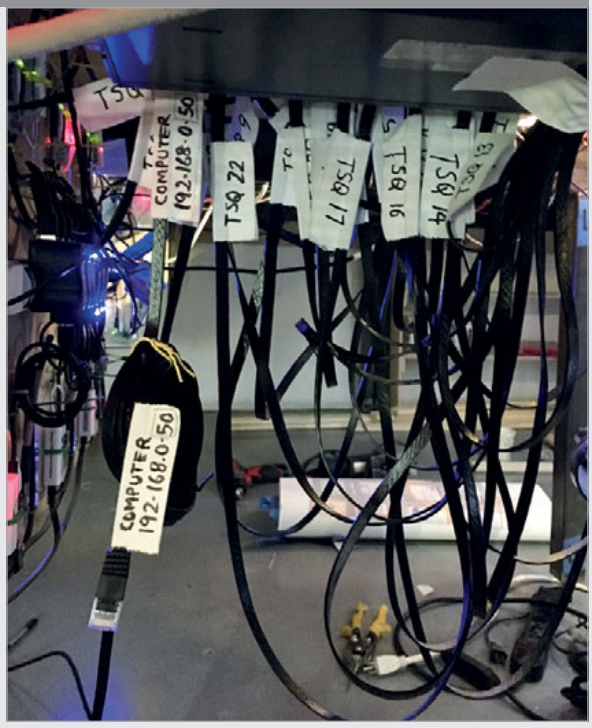
With all of that in place, they could attach the HDMI and power cables to the screen controllers. There wasn't enough room for standard cables, so they used HDMI flat angle adapters, which also provided a measure of safety. "The board wouldn't be damaged if someone accidentally yanked the cables," Uttam tells us. The cables were then secured with ties to keep them contained.

Coding real adverts

With construction complete, they could prepare the Pi Zeros. Uttam burned the Raspbian OS on to a microSD card using the Etcher app, and installed Adafruit's Raspberry Pi Video Looper to display the ads. "We used a library, so most of the programming task was already complete," he continues. "But to save some time in configuring all of the Pis, I wrote scripts to set static IPs and change host names."

The Pis have been connected to a 24-port Ethernet switch and placed under the platform on which the models sit. The team could then begin to gather adverts, which have come from the advertisers themselves, shining brightly from the buildings they adorn. "They really added depth and dynamism to the otherwise still buildings," Uttam says of the final result. "Targeting visitors by running real ads on the miniature screens is a real stroke of genius."

> "Targeting visitors by running real ads on the miniature screens is a real stroke of genius"



Above Every cable has been carefully labelled to make troubleshooting easier

INSTALL THE RASPBERRY PI DESKTOP X86

WARNING!
This tutorial erases the operating system running on your computer.

Use your free DVD to run and install the Raspberry Pi Desktop on your PC or Mac computer

You'll Need

- Mac or PC with optical drive
- The Raspberry Pi Desktop x86 DVD
- The Raspberry Pi Desktop x86 ISO image file
- USB thumb drive

Regular readers will know that we first gave away a copy of The Raspberry Pi Desktop operating system with issue 53 of *The MagPi*. Well, we're back with an update. The latest version of The Raspberry Pi Desktop x86 is included with the print edition of this month's magazine.

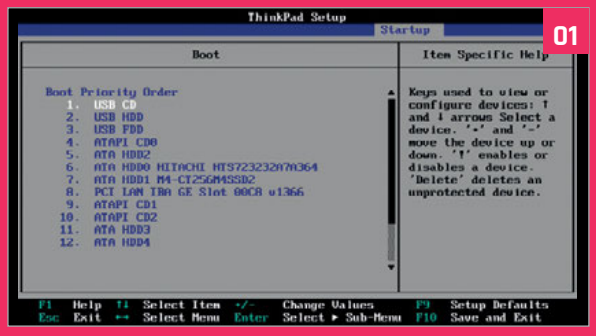
You can still run the Raspberry Pi Desktop on a PC or Mac computer, but now you can also install the Raspberry Pi Desktop on your hard drive, replacing the previous operating system.

This DVD is an ideal tool for adapting an old computer into a useful coding and hacking machine. The Raspberry Pi Desktop x86 runs on most computers with an Intel x86 architecture. We've run it successfully on many old PC and Mac devices.

Let's look at how to go about doing a basic installation of The Raspberry Pi Desktop x86 on an old PC or Mac computer.

The Raspberry Pi Desktop looks just the same as it does on a Raspberry Pi
The latest version of The Raspberry Pi Desktop x86 enables you to install the operating system on your computer
The Raspberry Pi Desktop DVD can be used on a PC or Mac computer

HOW TO: USE THE RASPBERRY PI DESKTOP X86

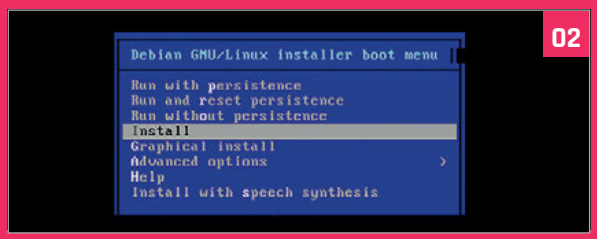

ThinkPad Setup
Startup
Boot
Item Specific Help
Boot Priority Order
1. USB CD
2. USB HDD
3. USB FDD
4. ATAPI CD0
5. ATA HDD2
6. ATA HDD0 HITACHI HTS723232A7A364
7. ATA HDD1 M4-CT256M4SSD2
8. PCI LAN IBA GE Slot 00CA v1366
9. ATAPI CD1
10. ATAPI CD2
11. ATA HDD3
12. ATA HDD4
Keys used to view or configure devices: 'f' and 'r' arrows Select a device. '+' and '-' move the device up or down. 'f' enables or disables a device. 'Delete' deletes an unprotected device.
F1 Help ↑↓ Select Item +/- Change Values F9 Setup Defaults
Esc Exit ↔ Select Menu Enter Select ▸ Sub-Menu F10 Save and Exit
01

>STEP-01

Boot from DVD on a PC

The free DVD bundled with the print edition of The MagPi #60 can be used to start up a PC or Mac computer with an optical DVD drive. Turn off your computer and insert the DVD. Most PC computers are set up to boot from the optical drive before the hard drive, and you should see the Debian GNU/Linux installer boot menu. If it does not boot from the DVD, you need to change the Boot Priority Order in your BIOS settings. On most PCs, you press **F1** during boot to do this.

Apple Mac computers are designed to boot from the hard drive first, and not from an inserted DVD. Insert the DVD into your Mac and shut it down. Now power it up and hold down the **C** key. The menu should boot from the DVD. If this doesn't work, hold down the **Option** key (marked 'alt') and choose the EFI Boot icon.

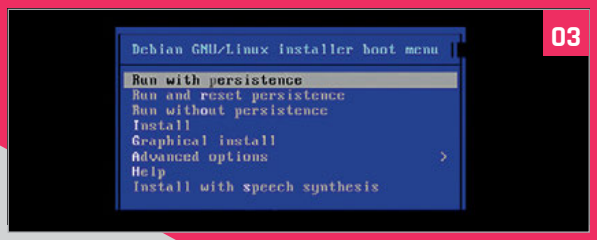


02

>STEP-02

Boot menu

The new version of The Raspberry Pi Desktop features a boot menu. Here you'll see seven options: Run with persistence, Run and reset persistence, Run without persistence, Install, Graphical install, and Advanced options.



03

>STEP-03

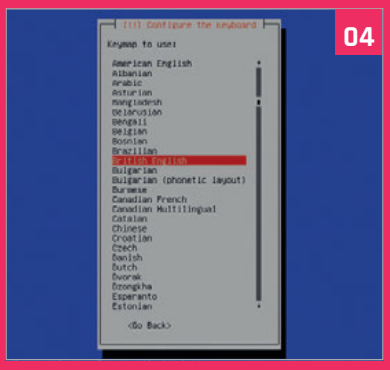
Run Raspbian

Choose 'Run without persistence' to quickly boot into the Raspberry Pi Desktop x86 operating system. Here you can experiment and play around. Be warned that it won't save any files. For this, you need to choose 'Run with persistence', and attach a USB pen drive to your computer. The persistence drive saves any files you create while using Raspbian (see The MagPi #53 for an in-depth explanation of persistence).

>STEP-04

Install

Two options are available: Install and Graphical install. Both offer a similar experience. You'll find additional settings under Advanced options. Select Install. Run through the Configuration options using the arrow keys and **Enter**. You'll now see 'Loading additional components'.

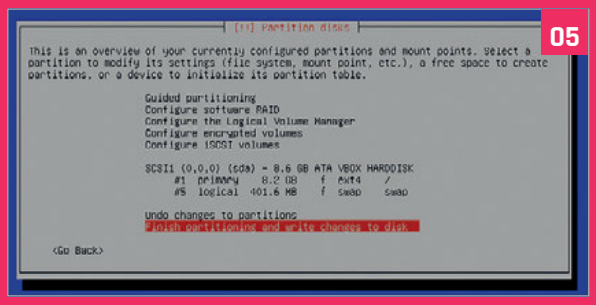


04

>STEP-05

Partition disks

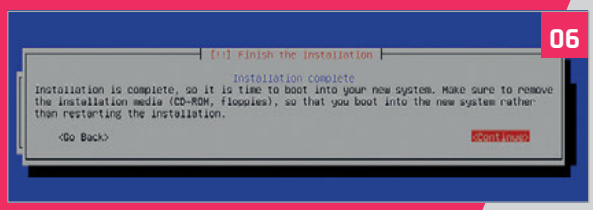
You have several options for partitioning disks. We're going with 'Guided – use entire disk'. Note that this wipes the original operating system! Choose the correct disk from the Partition Disks list and 'All files in one partition'. Finally, select Finish partitioning, write changes to disk, and Yes.


[!!] Partition disks
This is an overview of your currently configured partitions and mount points. Select a partition to modify its settings (file system, mount point, etc.), a free space to create partitions, or a device to initialize its partition table.
Guided partitioning
Configure software RAID
Configure the Logical Volume Manager
Configure encrypted volumes
Configure iSCSI volumes
SCSI1 (0,0,0) (sda) - 8.6 GB ATA VBOX HARDDISK
#1 primary 8.2 GB f ext4 /
#5 logical 401.6 MB f swap swap
Undo changes to partitions
Finish partitioning and write changes to disk
<Go Back>
05

>STEP-06

Installing the system

Wait for the system to be installed on your hard drive. Choose Yes to Install the GRUB boot loader on a hard disk, and pick your device from the list (typically it will be **/dev/sda** on a single disk machine). When you see 'Installation is complete', click Continue. Your computer will reboot and start up in the Raspberry Pi Desktop.


[!!] Finish the installation
Installation complete
Installation is complete, so it is time to boot into your new system. Make sure to remove the installation media (CD-ROM, floppies), so that you boot into the new system rather than restarting the installation.
<Go Back>
<Continue>
06

Problems?

With thousands of different types of machines, installation can go awry. If you encounter problems, ask the community for help at **raspberrypi.org/forum**

DISCOVER SCRATCH 2.0

Scratch 2.0 for Raspbian is packed with new features, and now runs offline

You'll Need

- Raspberry Pi
- Latest version of Raspbian
- Scratch 2.0

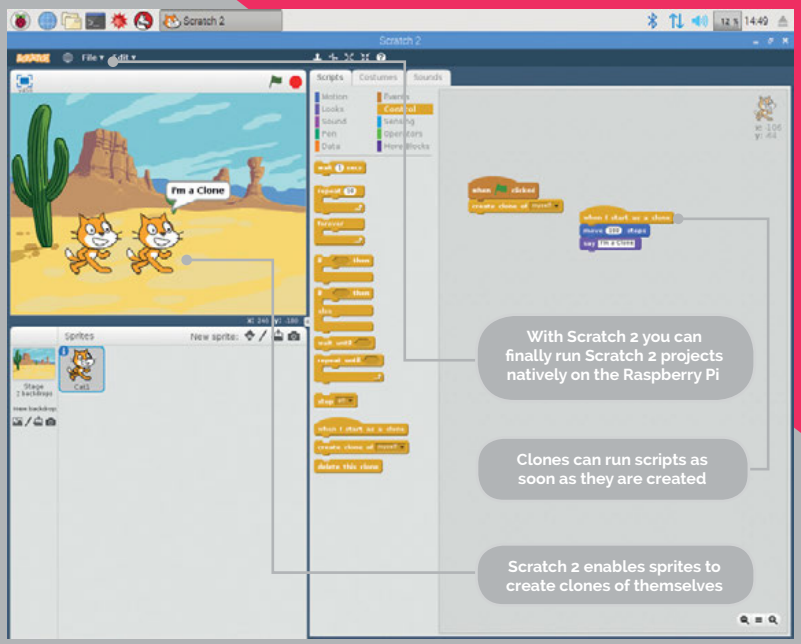
The latest update to Raspbian has brought the Scratch 2.0 offline app to the desktop. Scratch 2.0 for Raspberry Pi sits alongside Scratch 1.4 in the Programming menu, and brings a range of new features to the Scratch experience.

Scratch 2.0 is compatible with a vast range of projects available on the Scratch website (**scratch.mit.edu**). You can run Scratch 2.0 projects in the Chrome browser inside Raspbian, and then click File > Download to your computer. Open the file in the Scratch 2.0 program running on your Raspberry Pi (using File > Load Project), and the project will run offline.

Scratch 2.0 projects may not be compatible with the older Scratch 1.4 program, because Scratch 2.0 introduces lots of new features and blocks. One of the most exciting new features is cloning, which enables a sprite in your stage to clone, or semi-duplicate itself. Cloning is a powerful object-orientated programming (OOP) feature that was not supported in Scratch 1.4. It's an essential part of many games and projects.

You can also create custom blocks in the More Blocks section. This enables you to build your own blocks, and combine scripts that you use regularly into a single block.

There are plenty of other new features, including a sound editor, Time blocks, and vector editing. You can find a list of all the new features on the Scratch Wiki page (**magpi.cc/2s9T9ds**).

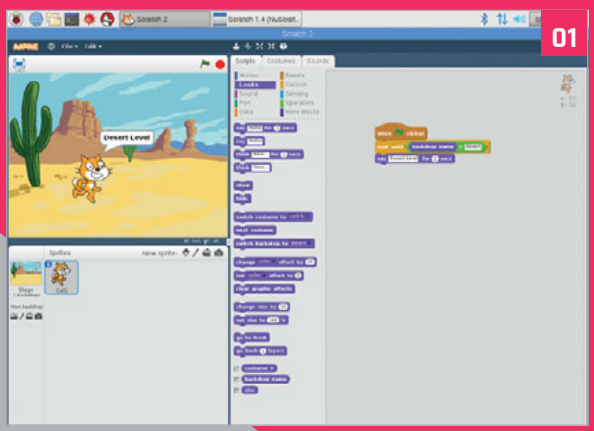

I'm a Clone
With Scratch 2 you can finally run Scratch 2 projects natively on the Raspberry Pi
Clones can run scripts as soon as they are created
Scratch 2 enables sprites to create clones of themselves

HOW TO: USE NEW FEATURES IN SCRATCH 2.0

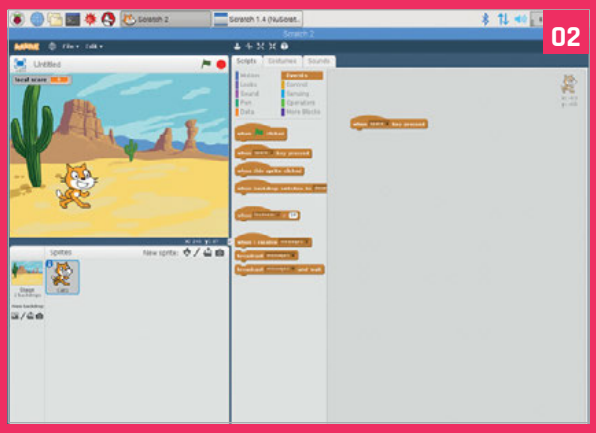
>STEP-01

Backdrop name

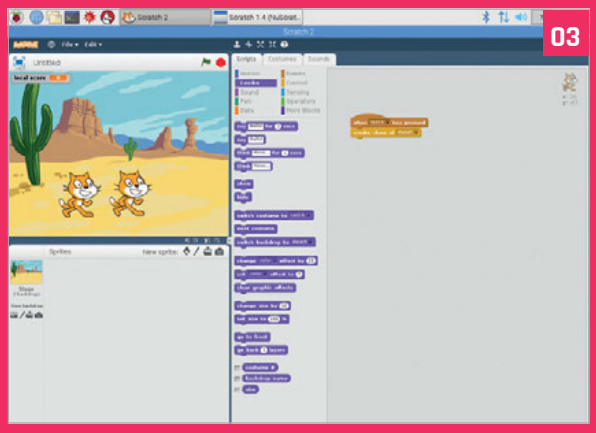
A new `backdrop name` block enables sprites to respond to specific backgrounds. You'll find `backdrop name` at the bottom of the Looks block set. Drag it into an Operator block inside a Control block, such as: `wait until backdrop name = desert` and `say Desert Level for 2 seconds`.



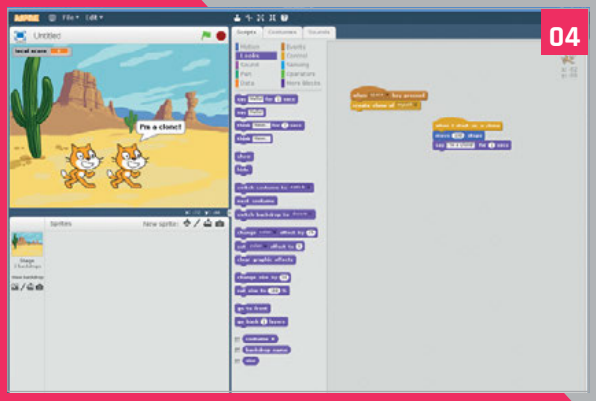
>STEP-02
Cloning
Cloning is a big deal in Scratch 2.0. You could create a single space alien, and clone it to provide a swarm of enemies. You can also delete cloned sprites when they have completed tasks. Start by dragging a **when space key pressed** block to the Scripts area.



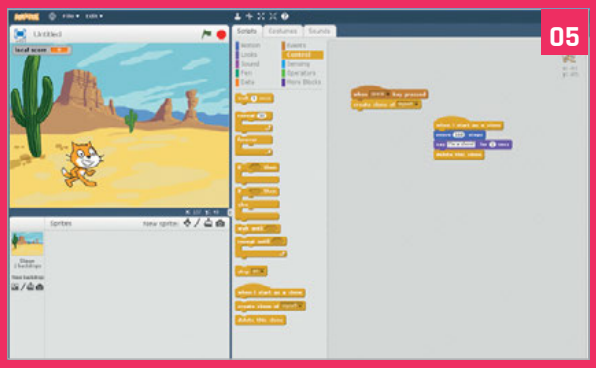
>STEP-03
Create a clone
Now click on Control, and at the bottom you'll see a **create clone of myself** block. Connect it to your **when space key pressed** block. The clone will appear in the same location as your sprite: press the **SPACE** bar and it will look as if nothing has happened. Click and drag the sprite, and you'll see that the clone appeared on top of the original sprite. Right-click and choose Delete to get rid of it.



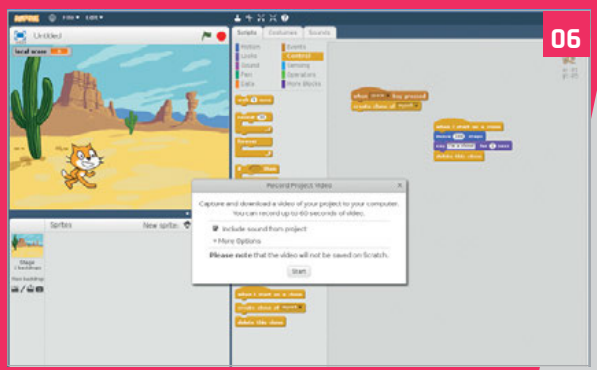
>STEP-04
When I start as a clone
Clones can automatically run blocks of code when they are created. Click on Control and drag a **when I start as a clone** block to the Scripts area. Beneath it, add a **move 100 steps** block. This helps you to differentiate between the two sprites. Now add a **say I'm a clone for 2 seconds** block. Press the **SPACE** bar and you'll see a new clone appear and announce itself. Right-click and Delete to get rid of it.



>STEP-05
Delete clone
Another neat feature is that clones can delete themselves. The Delete command makes it easy to quickly add and remove sprites from your scene (perfect for spawning and destroying enemies in a game). Add a **delete this clone** block to the bottom of the **when I start as a clone** block. Now the clone will announce itself and then disappear.



>STEP-06
Record video
Creating animations is one of the joys of Scratch, and a new Record Project Video option enables you to send a Scratch game or animation straight to a video clip. Choose File > Record Project Video and click Start to begin recording. A countdown will begin, and the recording will start. When you've finished recording, click the Stop icon below the Stage. Click Save, and the movie will be saved as a Flash Video (FLV) file. You need to install VLC to play back the movie (**videolan.org/vlc**).



CODE IN PYTHON WITH THONNY

Use the new Thonny IDE to understand what's going on in your code

You'll Need

- Raspberry Pi
- Latest version of Raspbian
- Thonny

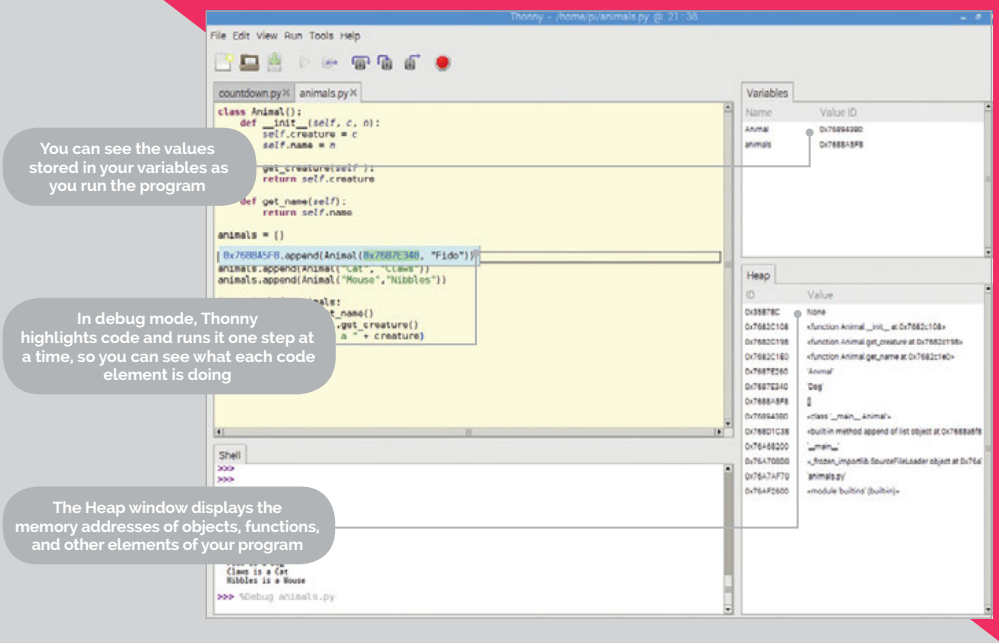
Thonny is a new IDE (integrated development environment) bundled with the latest version of the Raspbian operating system. Using Thonny, it's now much easier to learn to code. Thonny comes with Python 3.6 built in, so you don't need to install anything. Just open up the program, which you'll find under Menu > Programming. It offers a lot of advanced features not currently available in the Python 3 (IDLE) program, which is still included with Raspbian.

When you start Thonny, you'll see a new script editor and a shell. As with Python 2/3 IDLE, you enter a program in the script editor and run it in the shell. You can then use the shell to interact directly with the program; accessing variables, objects, and other program features.

Thonny has a range of additional features that are perfect for learning programming. One of the best features is a powerful, but easy-to-use, debug mode. Instead of running your program, it steps through the code line by line. You can see the variables and objects being created, and values being passed into functions or assessed by comparators.

You often find debuggers in powerful IDEs, but they tend to require you to manually set breakpoints (places where the program freezes so you can examine the code). The approach in Thonny is much more straightforward. It also has a range of panels that enable you to inspect various items, such as variables, objects, and the heap (the memory space where items are stored).

There's some pretty good stuff in Thonny for young coders. The ability to step through your programs makes it much easier to understand what happens when you hit Run.


You can see the values stored in your variables as you run the program
In debug mode, Thonny highlights code and runs it one step at a time, so you can see what each code element is doing
The Heap window displays the memory addresses of objects, functions, and other elements of your program

01

```
print("Hello World")
```

```
Python 3.4.2
>>> %Run hello.py
Hello World!
>>> name = "Lucy"
>>> print("Hello " + name)
Hello Lucy
```

>STEP-01

How to use Thonny

Click the Raspberry Pi Menu icon in the top left of the screen and choose Programming > Thonny Python IDE. We've used File > Increase Font Size so you can see the text more clearly. Enter this line of code in the script editor:

```
print("Hello World!")
```

Now choose File > Save and name the program **hello.py**. Click 'Run current script' (or press **F5**) to see the output in the shell. As with

Language
>PYTHON

DOWNLOAD:
magpi.cc/2t8CEhG

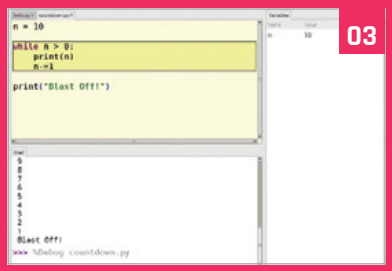
IDLE, you can also enter commands directly in the shell, such as:

```
name = "Lucy"
print("Hello " + name)
```

02

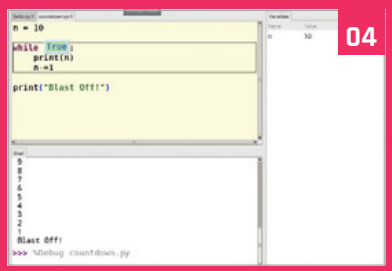
>STEP-02
Countdown

Let's see how you can walk through a file and see a variable change. Create a new script (File > New) and enter the code in **countdown.py**. Click Run and the code will display '10, 9 … 2, 1, Blast Off!' The **n** variable starts at 10. A **while** loop prints it, and decreases its value as long as it remains above zero.


03

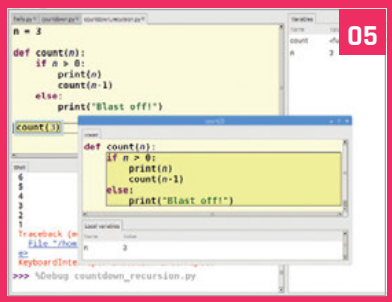
>STEP-03
Debug

Choose View > Variables and a new window appears displaying **n** and its current value (which is zero). Now let's run through it one step at a time. Click 'Debug current script'. The first line will be highlighted. Click Step Into and the value will be highlighted. Click it again, and both **n** and **10** are placed in the Variables window.


04

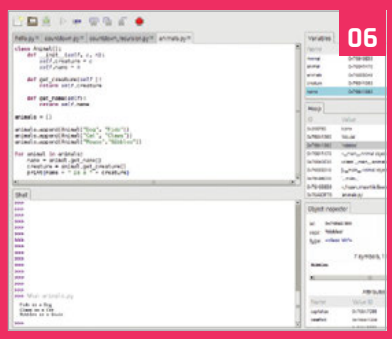
>STEP-04
Step through

Keep clicking Step Into and you will see the value of variable **n** (which is 10) added to the comparator and evaluated to **True**. Then the **while** loop will activate, the value of **n** will be displayed to the console, and **n** will decrease by 1. Click Step Out to run through the **while** loop and back to the main code.


05

>STEP-05
Recursion

Thonny's debug mode makes it easier to understand concepts such as recursion. Our **countdown_recursion.py** program runs a countdown recursively (a function which calls itself from inside itself). When the function calls itself, a new window appears with the function. Keep stepping through to see the values updated.


06

>STEP-06
Heap and objects

For a more detailed view, enter View > Heap and View > Objects. Now, as you work with object-oriented code, you can select objects in the Heap or Variables window and use the Object Inspector to check their type and attributes. The **animals.py** code creates animal objects with creature and name instance variables.

animals.py

```
class Animal():
  def __init__(self, c, n):
    self.creature = c
    self.name = n

  def get_creature(self ):
    return self.creature

  def get_name(self):
    return self.name

animals = []

animals.append(Animal("Dog", "Fido"))
animals.append(Animal("Cat", "Claws"))
animals.append(Animal("Mouse","Nibbles"))

for animal in animals:
  name = animal.get_name()
  creature = animal.get_creature()
  print(name + " is a " + creature)
```

countdown_recursion.py

```
n = 3

def count(n):
  if n > 0:
    print(n)
    count(n-1)
  else:
    print("Blast off!")

count(n)
```

countdown.py

```
n = 10

while n > 0:
  print(n)
  n-=1

print("Blast Off!")
```

MIKE'S PI BAKERY

MIKE COOK

Veteran magazine author from the old days and writer of the Body Build series. Co-author of *Raspberry Pi for Dummies*, *Raspberry Pi Projects*, and *Raspberry Pi Projects for Dummies*.
magpi.cc/259aT3X

FIDGET SPINNER MAZE RUNNER

Use your fidget spinner to speed through a medieval maze

You'll Need

- Fidget spinner
- Phototransistor
- NPN transistor and wires
- Stripboard
- Table light
- Wood strip and MDF sheet

Fidget spinners are the latest craze among young people. They are spreading fast, so we hope they don't peak and disappear before this publication hits the news stands! Fidget spinners might appear to be totally useless, but in this month's Pi Bakery we will transform one into a unique games controller.

We decided that the low-friction, free-spinning fidget would be most effectively interfaced with a computer using an optical connection. We dug out the SFH3410 sensor we used in the Amaze project in issue 39 of The MagPi, hoping that the small, low-profile sensor would sit neatly under the arms of a spinning fidget. Sadly, while it would fit underneath some types of fidgets, the contrast between shadow and light was not enough to reliably trigger a GPIO pin. Instead, we decided to hide the sensor under the lid of a box, and only admit light through a small hole. We added a general-purpose NPN transistor to the phototransistor to generate a robust 3V3 signal to send to the Pi. **Figure 1** shows the schematic diagram.

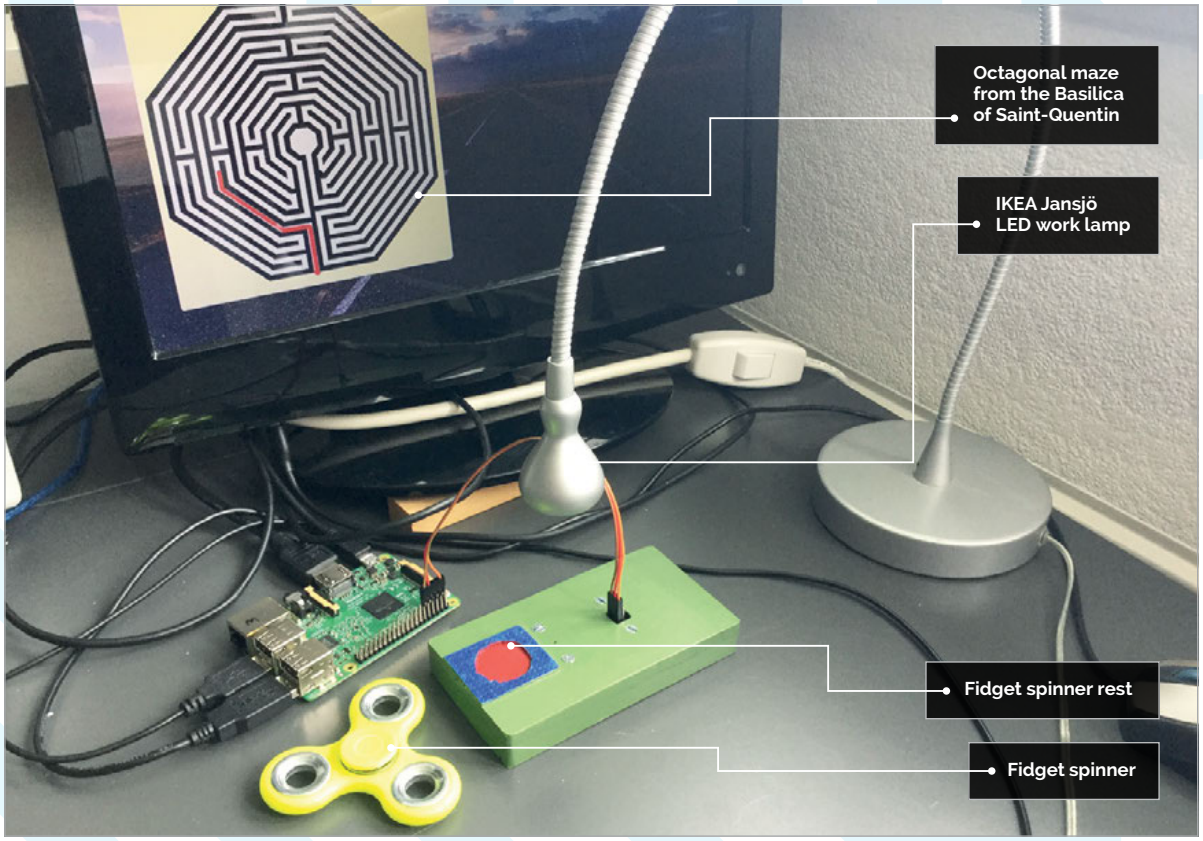
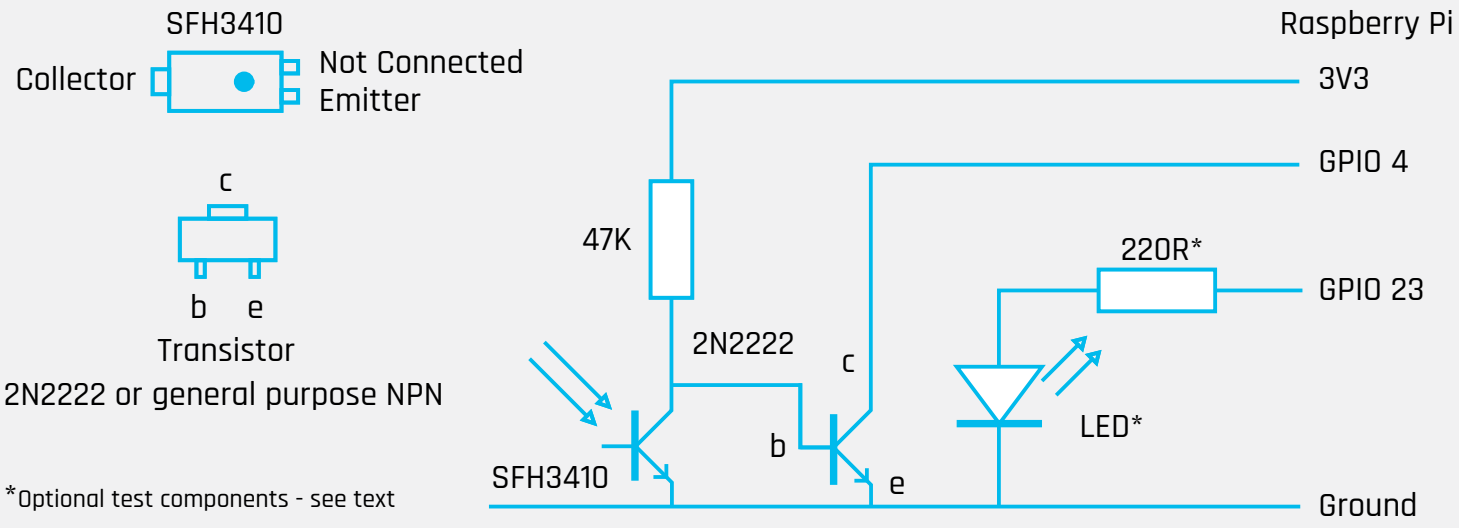


Figure 1 Schematic diagram of the fidget sensor



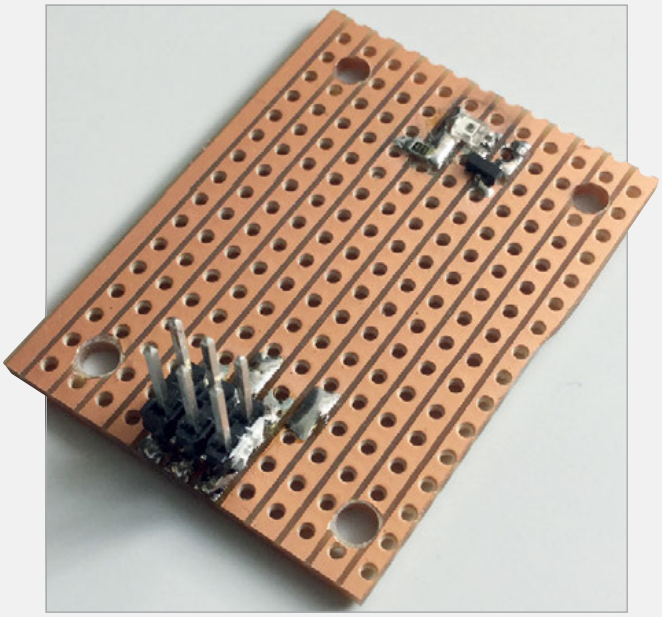
We aimed the light from a bright LED desk lamp into the sensor's hole and spun the fidget spinner to produce pulses of light. We tested the output on an oscilloscope, but we've added an LED to the circuit so you can test the signal without an oscilloscope. The LED is optional and doesn't form part of the working circuit, so omitting it has no effect on the operation.

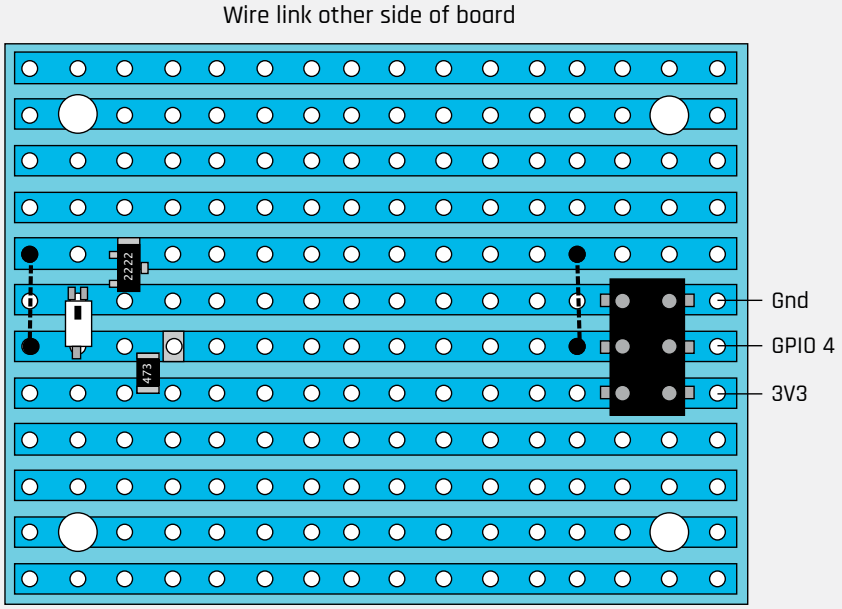
The fidgets we used had holes in each arm. This gave us 12 transitions between light and shadow, or signal edges, for one revolution of the fidget, as shown in **Figure 2** (overleaf). If you have a fidget without holes, you will only have six signal edges per revolution. You can easily compensate for this in the software. You will need to hold the centre of the fidget spinner down on the desk with your finger as you give it a spin, but you should be able to release it once it is moving.

MAKING THE FIDGET SENSOR

>STEP-01
Make the sensor board

We used a piece of 16×12 hole stripboard and surface-mount components, but you could easily use through-hole components and drill a hole in the stripboard to allow the light to shine through. The layout is easier to see in the diagram (right) than in the photograph (left). Cut the tracks around the holes in the two places marked with grey in the diagram. To wire the board to the Pi, we used a six-pin two-row surface-mount header pin connector.





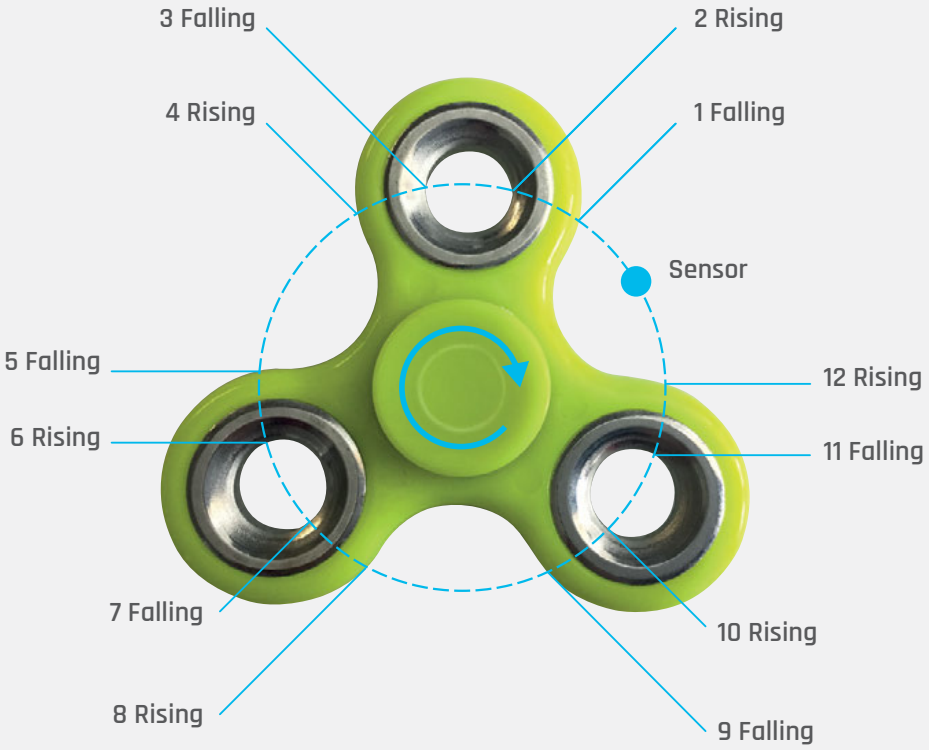


Figure 2 The progression of light and shadow as the fidget spinner rotates

Simple testing

When you have built the circuit, the first test is to display the fidget speed in rpm (revolutions per minute). This involves counting the light pulses produced by the spinner in one second, and then using that number to calculate the rpm figure. We used the GPIO callback function to count the edges of the signal being sent into the Raspberry Pi. To reduce the load on the computer, we only counted the falling edges – the signal changing from high to low when a shadow falls on the sensor. The code for this test is in **sensorTest.py.**

The pulse function is called when a negative or falling edge is detected on GPIO 4. This function does two things. First, the count variable is incremented, then the logic level on GPIO 23 is toggled. This divides the input signal by two, enabling us to check that no edges are being missed by the software. If you have a fidget with only six transitions per revolution, change the count increment to add two to the count at every falling edge.

Figure 3 Oscilloscope trace showing the input pulse (top trace) and the GPIO output feedback (bottom trace)

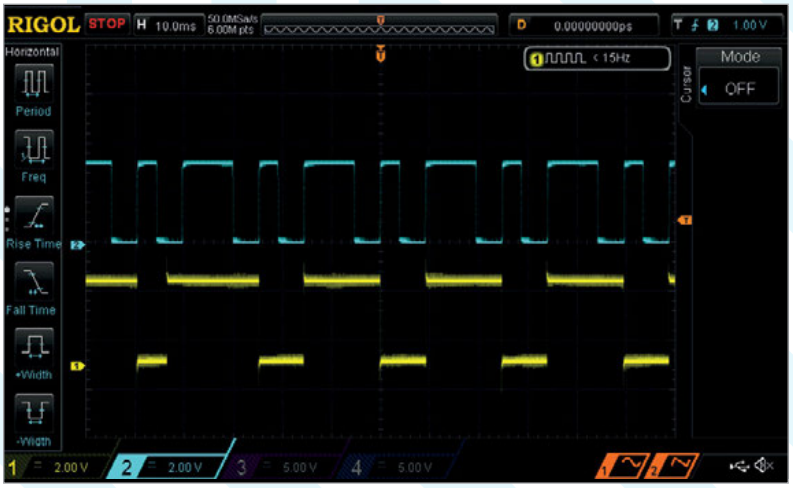


Figure 3 shows the oscilloscope trace, with a 5.6 ms latency between edge detection and function call. Note that the pulse widths are not even – this is because the angular distances between transition points are not equal.

With this simple code, you can compete to find who can get the fastest spinning speed from a fidget (either a standard spinner or your own customised lubricated one!). The fastest speed we measured from our fidgets was 840 rpm.

Mazes

The word 'maze' tends to be used in English, whereas the word 'labyrinth' is more widely used in other countries. There are many different types of maze – the one we are going to use is known as unicursal. You may be more familiar with puzzle mazes, which have branches and dead ends. In a unicursal maze, there is only one path to follow. There are no branches, so you can't get lost. Unicursal mazes are also known as processional mazes and are often walked for contemplation, usually in a religious setting.

The maze we are going to use here is a medieval octagonal maze pavement from the Basilica of Saint-Quentin in northern France. Using the fidget, you can compete to see who completes the maze in the shortest time, or how far though the maze can you run with a single fidget spin.

Software

The simplest way to use the edge count to control progress through the maze is to create a list of the coordinates of each pixel step along the path. With the scale we have used in this program, that amounts to about 8,000 coordinates. The player's current location in the maze can be calculated using the edge count as an index to the coordinate list. In order to generate the coordinate list, the program starts by finding its way through the maze and saving each point that it visits on the path. The end result is a bit of a fudge, but it does produce a useable coordinate list.

When you play the game, you can choose to see your progress as a trail, or as a point showing your

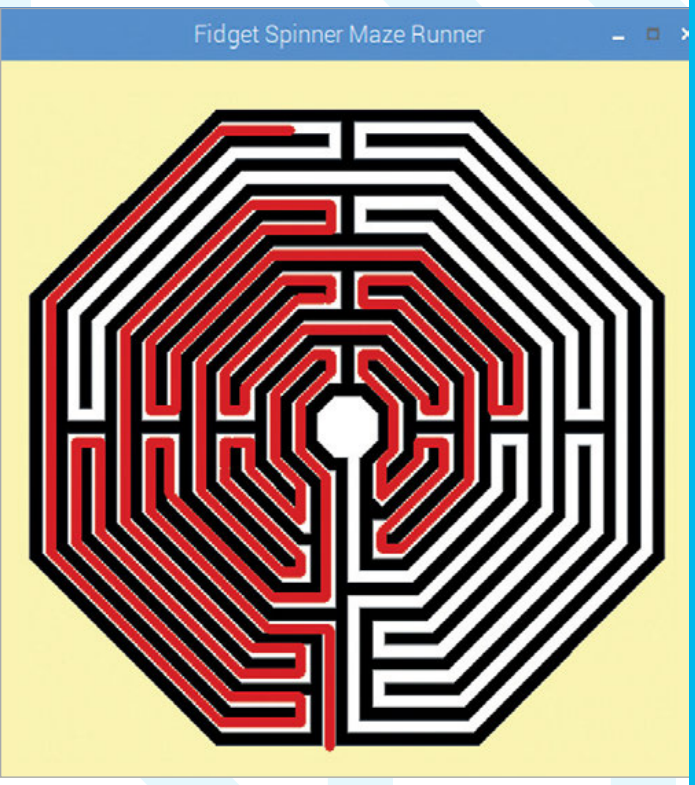


Figure 4 The maze on screen halfway through a run

location. We think the trail is best because it gives you instant feedback on how much of the maze you have visited, and how far you have to go. The **T** key will toggle between the two types of display. The **SPACE** bar resets the player's position to the start of the maze, and the **RETURN** key displays the number of fidget revolutions made so far. **Figure 4** shows the screen halfway through a game.

The strategy for playing this game is a bit like deciding when to make a pit stop in Formula One racing: you have to judge when you can safely give your fidget another spin without getting your fingers tangled up in it and bringing it to a stop.

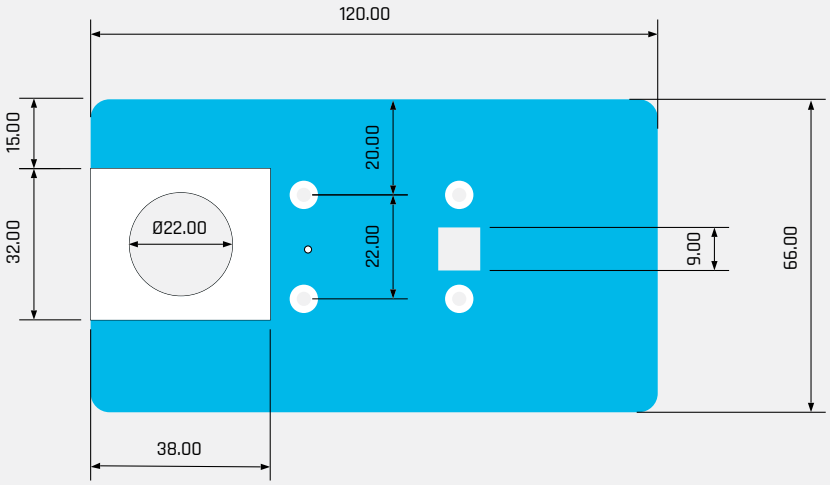
The **RETURN** key allows you to play the 'How far can you get with a single spin' game. The listing for this is shown in **mazeRunner.py**; it requires whistle and applause sound samples to be stored in a sounds folder, and the maze image in an images folder.

Taking it further

There are plenty of ways to expand this project. What about making the trail through the maze gradually change colour as it gets longer? How about building two of these fidget readers, so two players can race their coloured markers through the maze together? Another variation would be a tug of war game, using the difference between the two fidget counts to decide who is winning. When one player's count reaches a certain value, that player is declared the winner. This could be illustrated with graphics of the rope, and the people tugging on each side.

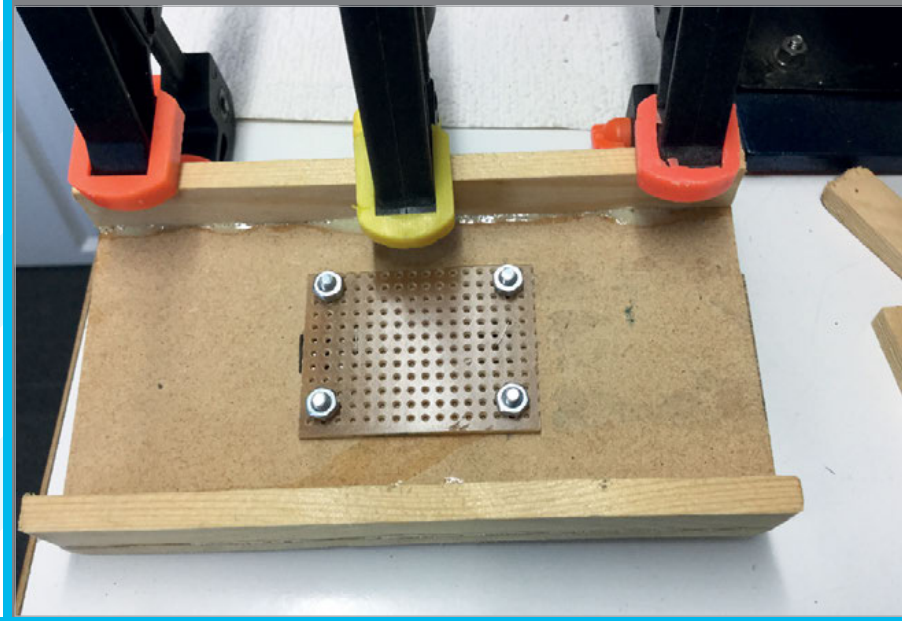
>STEP-02
Build the base

Take a piece of 6 mm MDF, about 120×65 mm in size. Drill and countersink four 3 mm holes for the circuit board. Drill a 1.5 mm hole to allow the light to get in, and countersink the underside of this hole to allow room for the phototransistor. Drill and file a square hole for the pin header. Cut a 22 mm hole out of a piece of 14×12 hole stripboard to act as the fidget rest, and glue it onto the board.



>STEP-03
Build the top

Use 10×6 mm strip pine to make four side panels, and glue and clamp them to the side of the top board. Paint the inside of the box with matt black paint, and the outside in the colour of your choice. We chose to paint the fidget rest in one colour, and the top, as seen through the hole in the rest, in a contrasting colour. Fit the electronics and connect everything to the Raspberry Pi's GPIO pins using a three-way ribbon cable.



mazeRunner.py

```
001. import pygame, time, os
002. import RPi.GPIO as io
003.
004. pygame.init()  # initialise graphics interface
005. pygame.mixer.quit()
006. pygame.mixer.init(frequency=22050, size=-16,
     channels=2, buffer=512)
007.
008. os.environ['SDL_VIDEO_WINDOW_POS'] = 'center'
009. pygame.display.set_caption("Figet Spinner Maze Run-
     ner")
010. pygame.event.set_allowed(None)
011. pygame.event.set_allowed([pygame.KEYDOWN,pygame.
     QUIT])
012.
013. screenWidth = 500 ; screenHeight = 516
014. screen = pygame.display.set_mode([screenWidth,scree
     nHeight],0,32)
015.
016. xPlot = 237; yPlot = 494 ; needsRedraw = True
017. direction = (0,-1) # start direction
018. feel = [(0,1),(1,0),(-1,0),(0,-1),(1,1),(-1,1),
     (1,-1),(-1,-1)]
019. rad = 6 # radius of your marker
020. mazePath = [] ; restart = False
021. mazePath.append((xPlot,yPlot))
022.
023. def main():
024.   global xPlot,yPlot,needsRedraw,rad,trail,progress
     ,count,restart
025.   print("Figet Spinner - Return for progress -
     Space for reset")
026.   init() # GPIO
027.   loadResorces()
028.   trail = True
029.   setupMaze(xPlot,yPlot)
030.   progress = 0
031.   markPath()
032.   setupMaze(mazePath[0][0],mazePath[0][1])
033.   rad = 4
034.   end = len(mazePath)
035.   while True:
036.     whistle.play()
037.     waitFinish()
038.     timeStart = time.time()
039.     count = 0
040.     while progress < end:
041.       checkForEvent()
042.       if needsRedraw:
043.         if trail:
044.           drawMaze(mazePath[progress]
     [0],mazePath[progress][1])
045.         else:
046.           setupMaze(mazePath[progress]
     [0],mazePath[progress][1])
047.           progress +=1
048.           needsRedraw = False
049.       if count != progress:
050.         progress = count
051.         needsRedraw = True
052.       if progress >= end:
053.         cheers.play()
054.         print("Finished")
055.         print("Maze Run Time",int(time.
     time()-timeStart),"seconds")
056.         waitFinish()
057.       if restart:
058.         progress = end
059.         restart = False
060.     progress = 0
061.     setupMaze(mazePath[progress]
     [0],mazePath[progress][1])
062.     time.sleep(2.0)
063.
064. def markPath():
065.   global xPlot,yPlot,direction,mazePath
066.   print("Finding path please wait")
067.   step = 0
068.   while 1:
069.     checkForEvent()
070.     while pathClear():
071.       (xPlot,yPlot) = (direction[0]+xPlot,dir
     ection[1]+yPlot)
072.       drawMaze(xPlot,yPlot)
073.       mazePath.append((xPlot,yPlot))
074.       if (xPlot > 255 and xPlot < 260) and
     (yPlot > 260 and yPlot < 268):
075.         print("Path found ready to play")
076.         return
077.     findDirection()
078.
079. def pathClear(): # is path ahead clear
080.   nextPoint = (direction[0]*(rad+1)+xPlot,
     direction[1]*(rad+1)+yPlot)
081.   col = screen.get_at(nextPoint)
082.   if col == (255,255,255,255) :
083.     return True
084.   return False
085.
086. def findDirection(): # where is free
087.   global direction
088.   direction = (0,0) # assume stuck
089.   i = 0
090.   while i<8:
091.     dirTest = (feel[i]
     [0]*(rad+2)+xPlot,feel[i][1]*(rad+2)+yPlot)
092.     col = screen.get_at(dirTest)
093.     if col == (255,255,255,255):
094.       direction = feel[i]
095.       i = 10 # end search early
```

Language
>PYTHON

DOWNLOAD:
magpi.cc/1NqJjmV

PROJECT VIDEOS

Check out Mike's Bakery videos at:
magpi.cc/1NqJnTz

```
    i +=1

def setupMaze(x,y):
  screen.blit(mazeImage,(0,0))
  pygame.draw.circle(screen,(210,0,0),(x,y),rad,0)
  pygame.display.update()

def drawMaze(x,y):
  pygame.draw.circle(screen,(210,0,0),(x,y),rad,0)
  pygame.display.update()

def loadResorces():
  global mazeImage,cheers,whistle
  mazeImage = pygame.image.load("images/maze.png").convert_alpha()
  cheers = pygame.mixer.Sound("sounds/end.ogg")
  whistle = pygame.mixer.Sound("sounds/whistle.ogg")

def init():
  global count
  count = 0
  io.setwarnings(False)
  io.setmode(io.BCM)
  io.setup(4, io.IN, pull_up_down=io.PUD_UP)
  io.setup(23, io.OUT)
  io.add_event_detect(4, io.FALLING, callback = pulse)

def pulse(channel): # call back function
  global count
  count += 2
  io.output(23,not(io.input(23))) #optional feedback

def waitFinish():
  while pygame.mixer.get_busy():
    checkForEvent()

def terminate(): # close down the program
  print ("Closing down please wait")
  pygame.mixer.quit()
  pygame.quit() # close pygame
  io.cleanup()
  os._exit(1)

def checkForEvent(): # see if we need to quit
  global trail,progress,restart
  event = pygame.event.poll()
  if event.type == pygame.QUIT :
    terminate()
  if event.type == pygame.KEYDOWN :
    if event.key == pygame.K_ESCAPE :
      terminate()
    if event.key == pygame.K_SPACE :
      restart = True
      # restart game
      print("Restarting")
    if event.key == pygame.K_RETURN :
      print("Pulses from Fidget", progress // 2,"or",progress / 6,"revoloutions")
    if event.key == pygame.K_t :
      trail = not(trail)
    if event.key == pygame.K_s :
      os.system("scrot")

# Main program logic:
if __name__ == '__main__':
  main()
```

sensorTest.py

```
import time, os
import RPi.GPIO as io
io.setwarnings(False)


io.setmode(io.BCM)
io.setup(4, io.IN, pull_up_down=io.PUD_UP)
io.setup(23, io.OUT) # feedback

count = 0

def pulse(channel):
  global count
  count += 1
  io.output(23,not(io.input(23)))

def main():
  global count
  io.add_event_detect(4, io.FALLING, callback = pulse)
  while 1:
    interval = time.time()
    lastCount=count
    while time.time() - interval <1.0:
      pass
    print((count-lastCount)*10,"RPM")

# Main program logic:
if __name__ == '__main__':
  try:
    main()
  finally:
    io.cleanup()
```

IKER GARCÍA

Born and raised in the Basque Country, Iker is studying for a PhD in Chemical Engineering. His hobby is programming, and learning about different devices.
twitter.com/hoopdreams1

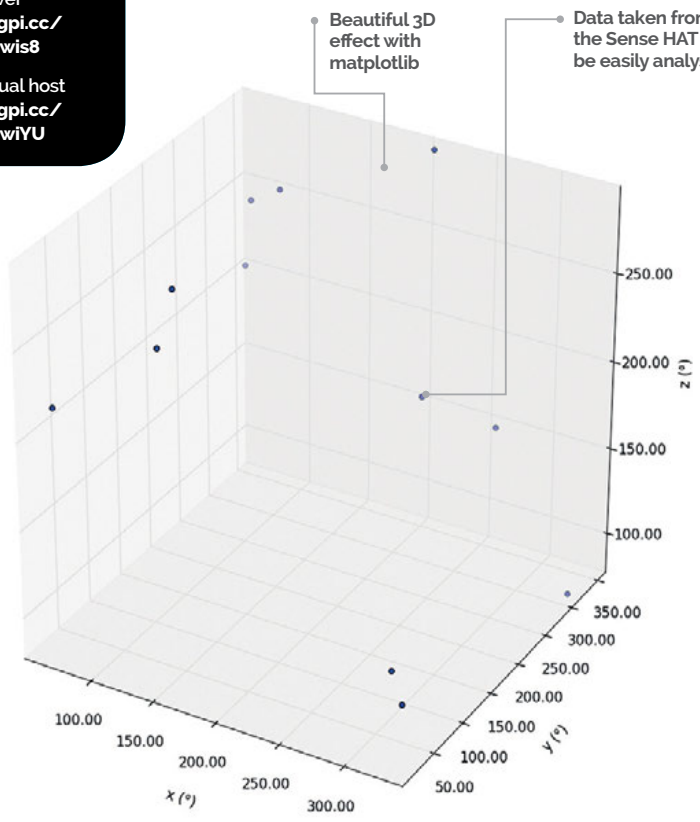
DASHBOARDPI: ORIENTATION WITH SENSE HAT

Plot Sense HAT data with matplotlib, and use a web server and a dashboard to track it wherever you are

You'll Need

- Sense HAT **magpi.cc/1TGGUt5**
- Dynamic DNS service **magpi.cc/1TSwg3g**
- Matplotlib **magpi.cc/1TSwgAt**
- Apache web server **magpi.cc/1TSwis8**
- Virtual host **magpi.cc/1TSwiYU**

If you cast your mind back to issue 46 of The MagPi, you'll remember that creating a plot with data obtained by the Sense HAT can help to make that data more understandable. Using Python together with the powerful **matplotlib** library, we can obtain and plot data from the Sense HAT sensors. If we have a web server running, we can create a virtual host where the plots can be stored and accessed over the network. This is known as a dashboard. There are existing services that would allow us to do this, but while most of them require a subscription, this one is free.



For details on how to create a dashboard for Sense HAT data, check out page 46 of The MagPi #46 (**magpi.cc/Issue-46**). The previous version of this project was focused on the use of temperature and humidity sensors, probably the easiest Sense HAT data to understand. This time, we are going to take advantage of the Sense HAT's powerful motion sensors.

We will use the matplotlib Python library to create two graphs: a 3D scatter plot using the XYZ position of the Sense HAT, and a 2D line plot using the angular velocity data.

Setting up the web server

With a dynamic DNS service, a web server and a virtual host, you can create your own dashboard. While these three items are not needed to create the plots, without them it would be only possible to track the results locally.

The first step is to create a folder called **dashboard** in **/var/www**. We will use this folder to save the CSV file generated by the program, along with all the data, and the HTML or PHP files, and use them to create a beautiful dashboard.

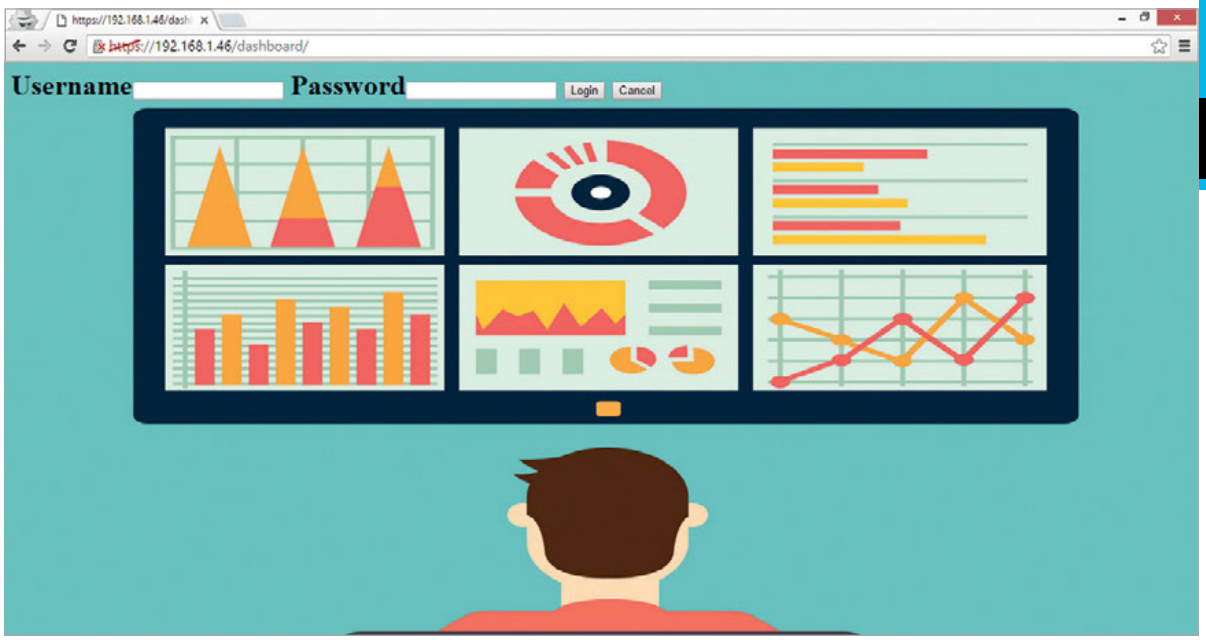
There are plenty of tutorials available online to show you how to design your dashboard, so we won't cover this here. When you have designed your dashboard, create a folder called **images** in **/var/www/dashboard**.

Importing libraries

Our code needs to import two libraries: **csv** in order to write the data to a file, and **matplotlib** to create the plots. After importing the libraries, we need to use the `matplotlib.use('Agg')` command to allow the program to work without a running X server. We also need to import **matplotlib.pyplot** in order to draw the plot, **matplotlib.ticker** to correctly format the axis, and **mpl_toolkits** in order to create the 3D plot. We need **NumPy** to work with the lists, and **SenseHAT** to gather

Language
>PYTHON

DOWNLOAD:
magpi.cc/2udxSB8



Left It is easy to create an attractive online dashboard using HTML

data from the Sense HAT. Finally, our code imports the **time** module in order to add a **`time.sleep`** to the **`while`** loop. This should have a value of a second or less if we want to get a realistic impression of the Sense HAT's movements from the motion sensors. The value of the **`time.sleep`** cannot be zero, as the angular velocity is calculated as displacement/time, and we cannot divide our displacement value by zero!

Manipulating data

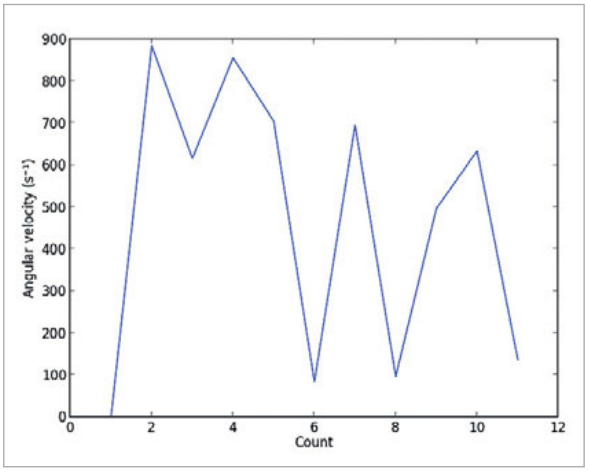
Matplotlib uses lists to create plots, so we need to create some empty lists. Our code will then take the data from the Sense HAT and add it to the lists. The code calculates the angular displacement, and then divides this value by the time in order to calculate the angular velocity. All this data is appended to a CSV file in case we want to check it later, or manipulate and analyse it using other hardware or software.

Creating the plot

We could take the data from the CSV file and create the plots, but matplotlib can do this easily using the lists we have created. Our code starts the 3D plot, then calculates the minimum and maximum values for the lists using **NumPy**. This information is used to format the axes before cleaning and saving the plot.

A similar procedure is used to plot the angular velocity against the data count. In this case we are creating a simple line plot. Our code defines the limits, using **NumPy** again to calculate the minimum and maximum values to be plotted. For this graph there is no need to format the axes, but we need to label them to make the plot easy to interpret. Finally, the code cleans and saves the plot.

The last step, just before ending the **`while`** loop, is to add the **`time.sleep`**, with a value greater than zero. If we want to produce a useful plot, this value should be close to 1 second or lower. The **`time.sleep`** value



Above Changes in orientation can be tracked using the angular velocity data

is set as a variable called **`snooze`**, just before the start of the **`while`** loop.

Using the data we have collected, we can track how the orientation of the Sense HAT has changed, and analyse the angular velocity of these changes.

This code is only an example of the things you could do using the Sense HAT data. You could create amazing projects using it as a base for your own code. You could create different plots, and use the measured data to correct the orientation of a rover or drone. You could then monitor the plots to double-check the resulting behaviour. You don't even need a Sense HAT – any sensors could be used, just by changing their references in the code.

Matplotlib was created by John D Hunter. He passed away in 2012. Everything your author has created using his amazing library, including this tutorial, is offered in his memory.

WENCESLAS MARIE SAINTE

Wenceslas is an electronics engineer who loves gadgets. He joined the personal seismometer adventure in 2015 and is passionate about making this technology available to anyone with an interest!
raspberryshake.org
twitter.com/raspishake

RASPBERRY PI EARTHQUAKE MONITOR

You'll Need

- Raspberry Shake board **magpi.cc/2t3BGE5**
- 4.5 Hz vertical geophone with cables **magpi.cc/2t36lMo**
- Preprogrammed SD card (optional) **magpi.cc/2t3myXf**
- Full kit (optional) **magpi.cc/2t3Eil9**
- Wired internet connection (optional)

The Earth is always shaking: from local tremors and traffic rumbling past, to the big earthquakes that hit half a world away. Now you can see it all!

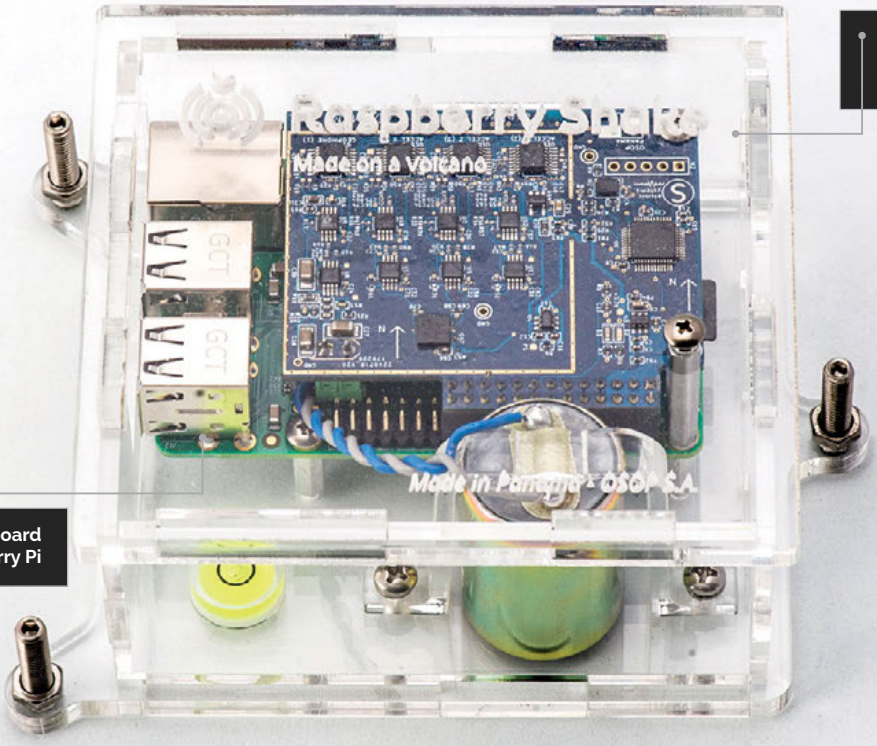
Watching the Earth's vibrations live from your computer is now a reality for anyone! The fun begins with Raspberry Shake, your professional-grade personal earthquake detection device, or seismograph. Raspberry Shake conveniently snaps directly onto a Raspberry Pi, along with a sophisticated Earth vibration sensor called a geophone, turning your Raspberry Pi into perhaps the smallest accurate seismograph in existence today. With the Raspberry Shake you can actually see, measure, and analyse the smallest movements of the Earth. It's so sensitive that you can see the vibrations change during rush hour, or with an event at your local sports stadium!

>STEP-01

Get the Raspberry Shake

Turning your Raspberry Pi into a sophisticated scientific instrument for personal seismology is easy, and only requires two additional parts: the geophone and the Raspberry Shake board. Everything you need is available at **shop.raspberryshake.org**.

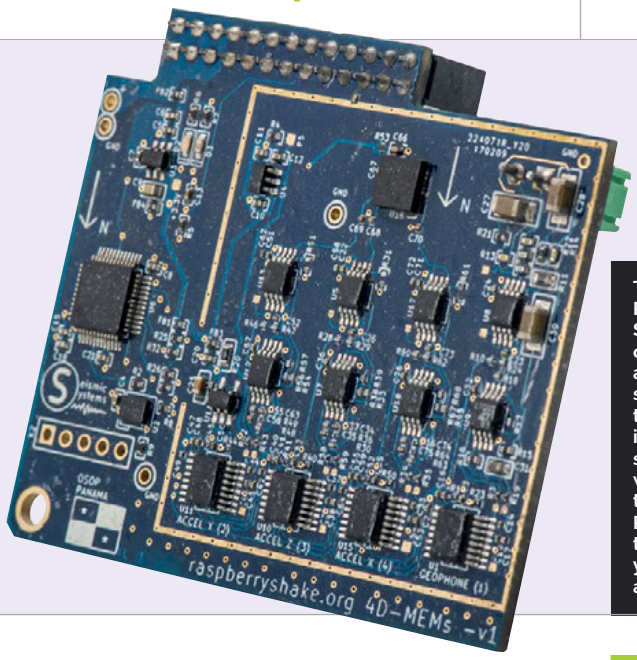
The main sensor is a geophone – think of it as a microphone for listening to vibrations in the Earth. The second component is the Raspberry Shake board. This is a sensor-digitiser that translates the data from the geophone, so you can actually see what is shaking! There's also a preprogrammed microSD card packed with custom coding, to make everything



The Raspberry Shake was designed by seismologists and electronic engineers

The Raspberry Shake board sits on top of a Raspberry Pi

The geophone is a rugged and exquisitely sensitive Earth motion sensor, finely tuned to accurately measure even the smallest vibrations and disturbances



The Raspberry Shake board converts the analogue signal from the geophone into a digital signal, and works with the Raspberry Pi to process the data for you to view and analyse

work together flawlessly. Alternatively, users can download the image and burn it to their own SD cards. You can buy an enclosure for your equipment, or you can use the laser cutter (DXF) and 3D printer (STL) source files to cut or print your own.

>STEP-02

Assemble the components

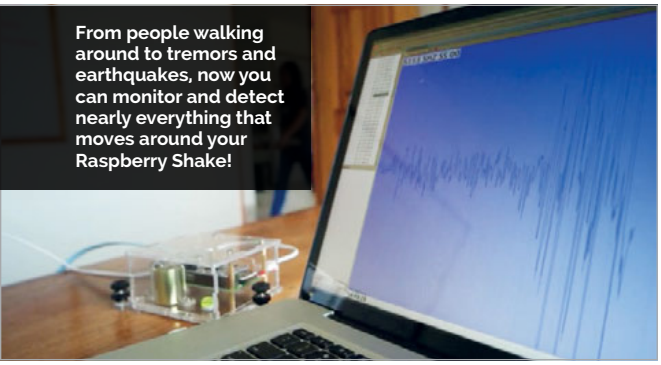
Whether you are a novice or an electronics expert, assembling the parts of this project should take less than five minutes. Follow the tutorial video on the Raspberry Shake website: go to **magpi.cc/2t3l9A9** and select *How to Assemble Your Raspberry Shake*.

The Raspberry Shake is compatible with many Raspberry Pi models, so this is the perfect project for resurrecting an older model and putting it to good use. The Raspberry Pi B, B+, 2, 3, Zero, and Zero W can all be used with the Raspberry Shake.

>STEP-03

Connect to your Raspberry Shake

Once you have all the parts assembled correctly, simply connect your Raspberry Pi to the internet and to a power supply as usual. The Raspberry Pi power lights will switch on, and a blue LED will light up on your Raspberry Shake board. Give it a few seconds to boot, then navigate in your browser to **raspberryshake.local**. This will give you instant access to the Raspberry Shake local web interface and configurations, so you can start watching the Earth move!



From people walking around to tremors and earthquakes, now you can monitor and detect nearly everything that moves around your Raspberry Shake!

>STEP-04

Join the official Shaker community

Congratulations on becoming a Shaker! There's an awesome community of hundreds of Shakers all over the world. If you enable data sharing in your device settings, you will be able to see your device alongside the rest of the Shaker community in the awesome interactive global map of live devices, at **magpi.cc/2t306k1**. With every device added to this network, the project's global data becomes more accurate, and it can analyse how the Earth as a whole is moving.

>STEP-05

Start watching the Earth shake!

The data from your brand new personal seismograph is presented in the industry-standard format (called miniSEED). Not only does this make the data incredibly useful to the global community, but it also means that you can access and use free and compatible software to watch earthquakes happen in real time. The United States Geological Survey (USGS) developed a program called SWARM to display and analyse data in real time – and it is 100 percent compatible with your Raspberry Shake. This is professional open-source software written by scientists working in volcanology and seismology. Download the software here: **magpi.cc/2t3ydp2**.

>STEP-06

Improve your data quality

Use the levelling feet and bubble level on Raspberry Shake's custom enclosures to make sure your device is completely level: **magpi.cc/2t3PY7w**. The enclosure design reduces ambient noise while allowing you to see the Earth's movement. It should even detect your washing machine's spin cycle!

USE 'IF THIS THEN THAT' INTEGRATION (IFTTT)

Use IFTTT to easily build smart connections between your personal seismograph and your home automation and IoT networks. Check out the 'Do It Yourself' section for more information: **magpi.cc/2t3nD1a**.

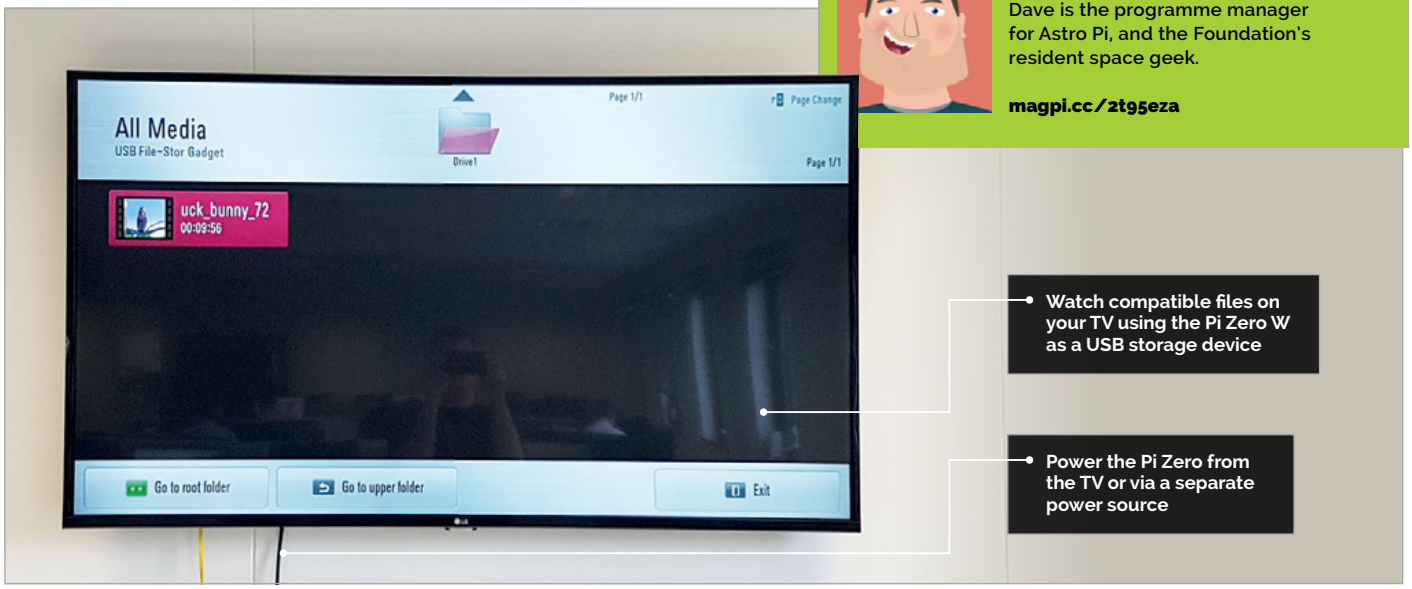
MAKE YOUR OWN CUSTOM ENCLOSURE

Why not customise the design of your enclosure, or personalise it with your name? Laser cutter (DXF) and 3D printer (STL) source files are available for your Raspberry Shake: **magpi.cc/2sl7zZ2**.

DAVE HONESS

Dave is the programme manager for Astro Pi, and the Foundation's resident space geek.

magpi.cc/2t95eza


All Media
USB File-Stor Gadget
Drive1
Page 1/1
Page Change
Page 1/1
uck_bunny_72
00:09:56
Go to root folder
Go to upper folder
Exit
Watch compatible files on your TV using the Pi Zero W as a USB storage device
Power the Pi Zero from the TV or via a separate power source

You'll Need

- Raspberry Pi Zero W
- USB-A to micro USB-B cable (plus an optional extra cable you don't mind modifying)

PI ZERO W SMART USB PEN DRIVE

Wirelessly send files to a USB pen drive inserted into your TV, milling machine, or lathe using a Pi Zero W in USB device mode!

Built-in wireless on the Pi Zero W opens up a huge number of possibilities for the various USB gadget modes. The Pi Zero W can be configured to spoof different USB device types, such as a keyboard, a webcam, or a USB pen drive. At home, many people use a USB pen drive to transfer files to a TV, but it takes time to move the drive to and from the source computer. How about a remotely accessible USB pen drive, permanently located in the TV, where you could transfer files using the wireless connection? Drag and drop, job done!

>STEP-01

Get on the wireless

On Raspbian Jessie, wireless connections can be made via the networking icon on the right-hand end of the desktop menu bar. Left-clicking the icon will bring up a list of available networks. If you see the scanning message, wait for a moment and it should find your network.

Click the network that you want to join. If the network is secured, you will see a dialogue box. Enter the password, click OK, and wait for a few seconds. Finally, write down the IP address the Pi has acquired. Hover the mouse over the signal strength icon and the IP address will appear in a tooltip. If you prefer, you can complete this process on another Pi, and move the SD card over to the Pi Zero W when you reach Step 03.

>STEP-02

Disable desktop and enable SSH

From this point we don't need the desktop, because the Pi Zero is going to have one job: to be a file server for the TV. To save CPU cycles, we should disable the automatic boot to desktop. Go to Menu (Raspberry icon at the top-left corner of the screen) > Preferences > Raspberry Pi Configuration.

On the System tab, find the Boot option. Select 'To CLI' (command line interface), and disable the 'Login as user pi' checkbox.

On the Interfaces tab, make sure that SSH is enabled. Click OK and choose Yes to reboot. After the reboot, you should see a text login prompt with a flashing cursor.

>STEP-03

Switch to remote access

We recommend using SSH (Secure Shell), because we'll be doing everything using the command line. SSH allows us to see the Raspberry Pi command prompt in a window on another PC, Mac, smartphone, or tablet.

Go to **magpi.cc/2sLqBmM** and follow the instructions for the platform you're using. You'll need the IP address you wrote down earlier, and the login. The default login for Raspbian is **pi**, with the password **raspberry**.

When the SSH link is working, you can disconnect any keyboard and screen.

>STEP-04

Free up some disk space

When you've logged in over SSH, you can free up disk space by removing some programs that we're not going to need for this project.

The command **`df -h`** shows your disk space usage. Look at the **`Avail`** column for **`/dev/root`** to see how much free space you have. We can claw back about 1GB if we remove LibreOffice and Wolfram.

Enter the commands below into your SSH client:

```
sudo apt-get remove --purge libreoffice* -y
```

You can safely ignore any errors you see here. They happen because the command will try to remove some parts of LibreOffice that aren't actually installed.

```
sudo apt-get purge wolfram-engine -y
sudo apt-get clean
sudo apt-get autoremove -y
```

Now **`run df -h`** again and check the **`Avail`** column.

>STEP-05

Enable the USB driver

Next, we need to enable the USB driver which provides the gadget modes, by editing two configuration files.

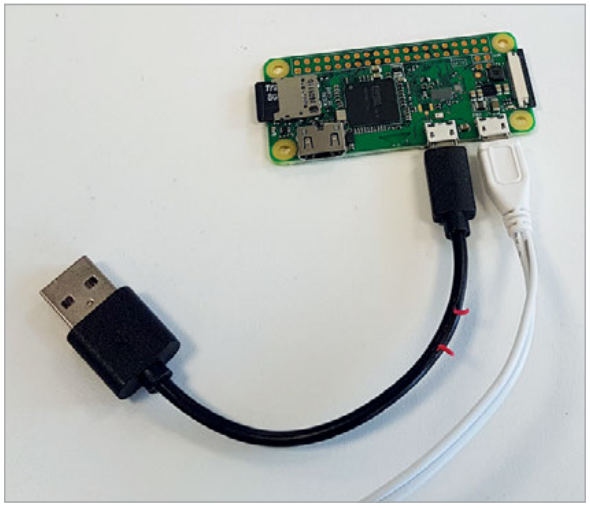
```
sudo nano /boot/config.txt
```

Scroll to the bottom and append the line below:

```
dtoverlay=dwc2
```

Press **CTRL+O** followed by **ENTER** to save, and then **CTRL+X** to quit.

```
sudo nano /etc/modules
```



Left Use a modified cable to keep the Pi Zero W powered, even when the TV is switched off

Append the line below, just after the **`i2c-dev`** line:

```
dwc2
```

Press **CTRL+O** followed by **ENTER** to save, and then **CTRL+X** to quit.

Now shut down the Pi Zero W with the command:

```
sudo halt
```

>STEP-06

Switch to TV power

On the Pi Zero W, you'll see two micro USB ports. One is marked 'USB' and the other 'PWR IN'. You can supply power through either port, but the USB port is for data as well. There are two options.

You could plug the TV into the Pi Zero W USB port, not the PWR IN port, using a standard micro USB cable. The cable will both supply power from the TV and make the USB data connection. The disadvantage is that the TV must be switched on to supply power to the Pi. When someone turns the TV off with the remote, the Pi will also lose power, which can corrupt your SD card.

Alternatively, you can connect a separate, always-on power supply to the PWR IN port, and use a slightly modified micro USB cable to connect the TV to the USB port. The modification is to cut the **red** wire inside the micro USB cable. This protects the Pi from damage that could be caused by drawing power from two different power sources. The advantage of this method is that the Pi is powered independently from the TV. It will be available on the network even if the TV is off, and there is a reduced risk of sudden power loss and SD card corruption.

You might want to test the system with the first option, and then move onto the second when you want a more permanent setup. Don't forget to cut the red wire if you use the second option.

Connect the Pi Zero W USB port to the TV using your chosen method, power everything up, and log back in over SSH.

>STEP-07
Create a container file

To enable mass storage device mode, we need to create a large file to act as the storage medium on the SD card. This file will emulate the USB pen drive that the TV sees.

The command below will create an empty 2GB binary file (change the **count=2048** parameter if you want a different size). Please note that this will be limited by the available free space on your SD card (check the **Avail** column in **df -h**), and it may take a few minutes to complete the setup:

```
sudo dd bs=1M if=/dev/zero of=/piusb.bin
count=2048
```

We now need to format the file as a FAT32 file system so that the TV can understand it. Enter the command below:

```
sudo mkdosfs /piusb.bin -F 32 -I
```

>STEP-08
Mount the container file

Now let's mount the container file locally so we can download some test files. First, create a folder on which we can mount the file system:

```
sudo mkdir /mnt/usb_share
```

Now let's add this to **fstab**, the configuration file that records our available disk partitions:

```
sudo nano /etc/fstab
```

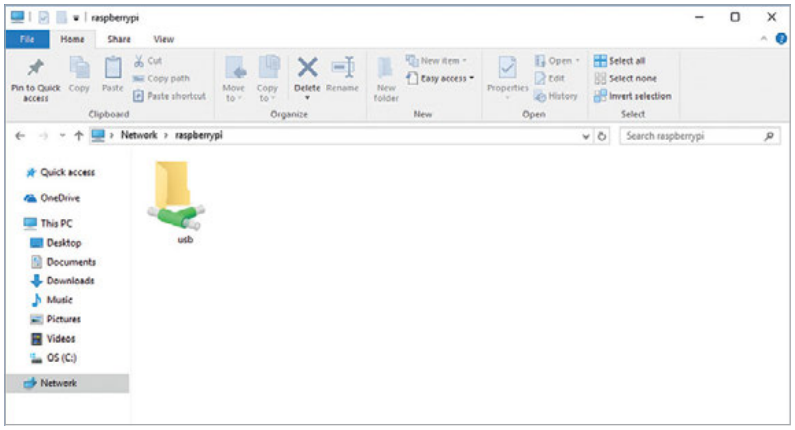
Append the line below to the end of the file:

```
/piusb.bin    /mnt/usb_share    vfat
users,umask=000    0    2
```

Press **CTRL+O** followed by **ENTER** to save, and then **CTRL+X** to quit.

The line we added to **fstab** allows the USB file system to be error-checked and mounted automatically at boot time. Instead of rebooting, we can manually reload **fstab** with the command below:

```
sudo mount -a
```



Below Connect to the Pi Zero W over the network using Samba for easy file transfers

>STEP-09
Download a test file

Now let's download a 300MB test file to view on the TV. *Big Buck Bunny* is a short open-source film, made by the Blender Foundation (**www.blender.org**), and released under the Creative Commons Attribution License 3.0:

```
cd /mnt/usb_share
wget http://download.blender.org/peach/
bigbuckbunny_movies/big_buck_bunny_720p_
surround.avi
```

You'll see a progress bar move from left to right. When the download is complete, run a command to flush any cached data to the disk:

```
sync
```

>STEP-10
Test mass storage device mode

Now comes the moment of truth. Let's see whether the TV is going to be friends with the Pi Zero W. The command below will enable USB mass storage device mode, and the TV should pop up a dialogue box. If it doesn't, you may need to use the Input or Source button on the TV remote to select the USB device.

```
sudo modprobe g_mass_storage file=/piusb.
bin stall=0 ro=1
```

The TV should provide a file browsing interface. Locate the *Big Buck Bunny* file and hit Play.

Once you're satisfied that all is well, try a dismount:

```
sudo modprobe -r g_mass_storage
```

The correct behaviour here is for the film or browsing interface to disappear from the screen. You may see a message saying that the USB device was disconnected.

>STEP-11
Install and configure Samba

The next step is to provide network access to the **/mnt/usb_share** folder that we created earlier.

```
sudo apt-get update
sudo apt-get install samba winbind -y
```

When the installation is complete, we need to configure a Samba network share. For simplicity,

this will not require a user name or password, as it is already protected by your wireless network security. If you want more security, see **wiki.samba.org**.

```
sudo nano /etc/samba/smb.conf
```

Scroll down to the end of the file and append the lines below:

```
[usb]
browseable = yes
path = /mnt/usb_share
guest ok = yes
read only = no
create mask = 777
```

Press **CTRL+O** followed by **ENTER** to save, and then **CTRL+X** to quit.

Now restart the Samba service for the changes to take effect:

```
sudo systemctl restart smbd.service
```

>STEP-12

Access the share from another computer

Now we can try to access the share from a Windows PC or a Mac. You'll need the host name the Raspberry Pi is using. To check this, enter the command below:

```
cat /etc/hostname
```

By default this will be **raspberrypi**.

In Windows, you can bring up Explorer (**Windows** key + **E**) and type **\\raspberrypi** into the address bar at the top. The Run dialogue also works (**Windows** key + **R**).

On macOS, the Raspberry Pi will show up in the Finder sidebar. Alternatively, from the Finder menu, select Go > Connect to server (**Apple** key + **K**) and type **smb://raspberrypi** as the server address.

Depending on your network settings, you may still see a login dialogue. Any user name, including a guest or anonymous login, will work. Once you're in, you'll see a share named **usb**. Open this and test that you have write access, either by creating a new folder or by copying over a file.

You can enable mass storage device mode to check that the TV can see your changes, but don't forget to run the **sync** command first.

If you want to change the host name, edit the name in **/etc/hostname**. Make the same change in **/etc/hosts**, and finally use **sudo reboot** to apply the changes.

>STEP-13

Automate USB device reconnect

In order for the TV to detect any changes we've made over the network (for example, file or folder creations and deletions), it needs to be tricked into thinking that the USB device has been removed and reinserted.

We can use a Python library called watchdog (**magpi.cc/2sLL1fi**), which is designed for monitoring file system events and responding to them. Install this with the command below:

```
sudo pip3 install watchdog
```

We then need some code to start a timer whenever something changes in the shared folder. The timer is reset to zero every time a new change occurs, and the USB reconnect is only triggered if we see 30 seconds of inactivity after a change. This avoids spamming the TV while we're copying over multiple files.

We've written a program to do this. To download it, type:

```
cd /usr/local/share
sudo wget http://rpf.io/usbzw -O usb_share.py
sudo chmod +x usb_share.py
```

>STEP-14

Background service

We need to make this program into a background service, so that it starts automatically at boot time. We can do that by making it into a **systemd unit**. Enter the commands below:

```
cd /etc/systemd/system
sudo nano usbshare.service
```

This will start a new blank file. In the new file, enter:

```
[Unit]
Description=USB Share Watchdog

[Service]
Type=simple
ExecStart=/usr/local/share/usb_share.py
Restart=always

[Install]
WantedBy=multi-user.target
```

Press **CTRL+O** followed by **ENTER** to save, and then **CTRL+X** to quit.

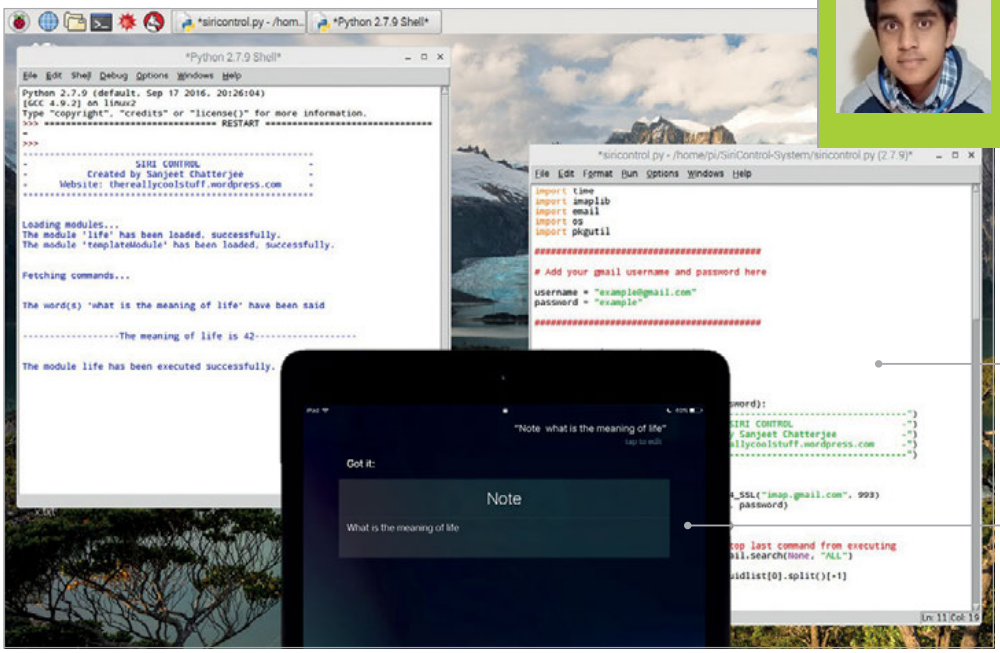
Now we need to register the service, enable it, and set it running:

```
sudo systemctl daemon-reload
sudo systemctl enable usbshare.service
sudo systemctl start usbshare.service
```

Whenever you copy files over to the network share, the USB device should automatically reconnect to the TV after 30 seconds of inactivity.

SANJEET CHATTERJEE

15-year-old technology enthusiast and self-taught programmer with a knack for creativity. Passionate about studying robotics and AI.
magpi.cc/2t3oJtK



SiriControl fetches the commands from your Gmail account, and runs the appropriate module

Siri creates a note with your command, which syncs with your Gmail account

SIRICONTROL: CONTROL YOUR PI WITH SIRI

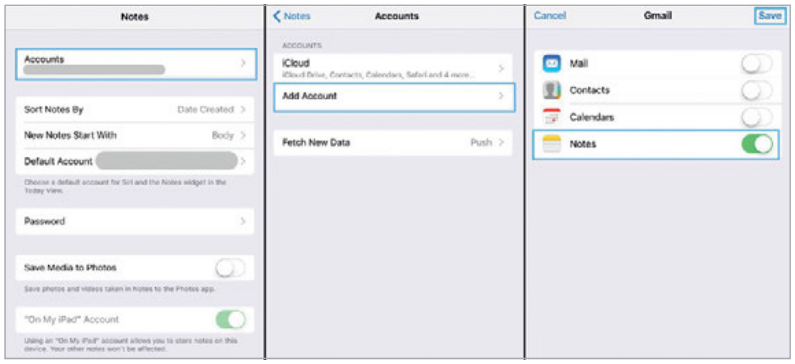
You'll Need

- iOS device
- SiriControl: **magpi.cc/2t3Bh4v**

SiriControl is a framework, written in Python, which implements an ingenious hack to enable you to add Siri voice control to any project

Siri is an intelligent personal assistant, integrated with Apple devices. From setting reminders to hailing taxis, Siri can do many things to make life easier. However, wouldn't it be awesome if you could control anything with Siri?

Welcome to SiriControl – a Python framework which provides a simple way of using Siri voice commands to add fantastic voice control to any project. The possibilities for SiriControl are endless, and as no extra hardware is required: you can get started right away!



Above You will need to add your Gmail account so that the Notes can be synced with it

>STEP-01

How it works

Siri can create Notes by using the command word 'note'. The new Note is then synced with the linked Gmail account. SiriControl fetches the new Note from the Gmail account, and executes the appropriate function from the dynamically loaded modules created by the user. This ingenious hack enables you to add fantastic voice control capabilities to any project, with minimal setup required.

>STEP-02

Configure Gmail

A Gmail account is required for SiriControl. For security reasons, we suggest creating a new Gmail account specifically for SiriControl, as you will have to enter your credentials in a Python script.

Access for less secure apps needs to be enabled for your new account as Google identifies the connection between the Python script and mail servers as less secure – see **magpi.cc/2u3gprx**.

IMAP must also be enabled. This is found in the Gmail account settings, as shown in the image (on next page). This is the protocol SiriControl uses to fetch new Notes.

>STEP-03

Prepare your iOS device

The Notes need to be synced with your Gmail account so that SiriControl can fetch the voice commands that you say, through Siri. So navigate to Settings > Notes > Accounts > Add Account on your iOS device, and add your new Gmail account.

After turning on Notes, ensure that the default account for creating Notes is the new account. Now, if you say to Siri, "Note this is awesome," it should appear under the Notes section, under your Gmail account.

>STEP-04

Set up SiriControl

Finally, you will need to clone the SiriControl repository using:

```
sudo apt-get update

sudo apt-get install git-core

git clone https://github.com/
theraspberryguy/SiriControl-System
```

Edit **sericontrol.py** and enter your Gmail account credentials. This should be self-explanatory once the script is opened up.

Next, run **sericontrol.py** and say to Siri: "Note meaning of life."

You should get the answer. That's it! You have finished the SiriControl setup. Now, let's add your own voice commands.

>STEP-05

Create your own modules

SiriControl uses a modular approach for adding your own commands. Each voice command, along with its action, is separated into different modules, found in the **modules** folder.

Every module must have the following:

`moduleName` – this is the name of the module, which can be anything you want.

`commandWords` – this array will contain the words which need to be spoken in order to call the **`execute()`** function.

`execute(command)` – this function is called when all the words in the **`commandWords`** array are spoken. The **`command`** parameter is the complete command spoken by the user.

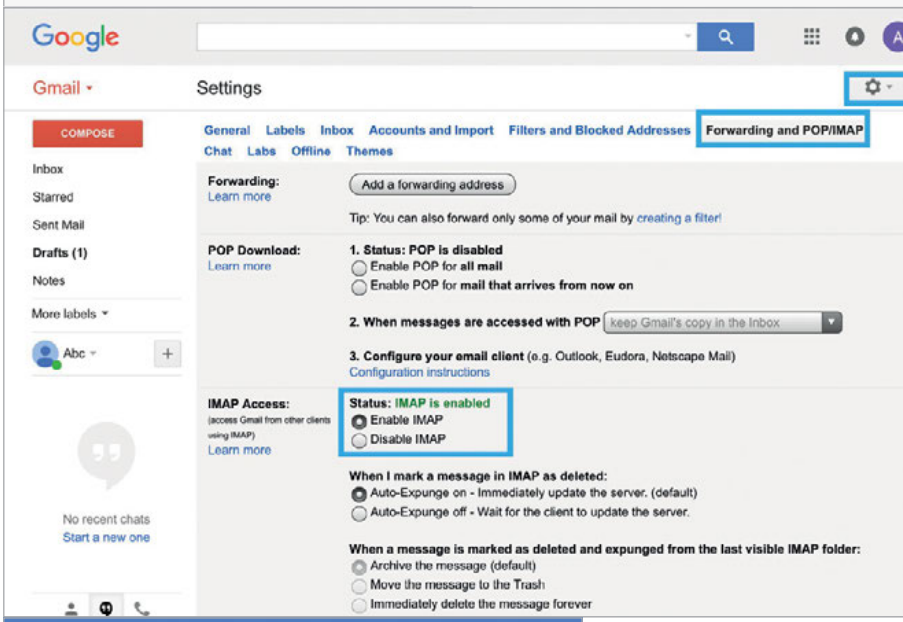
Take a look at the **life.py** module, which comes with SiriControl, to gain a better understanding of how it works. Also, keep in mind that all modules you create must be stored in the **modules** directory for SiriControl to load when it starts up. The template **Module.py** is also included with SiriControl, which can be used as a reference.

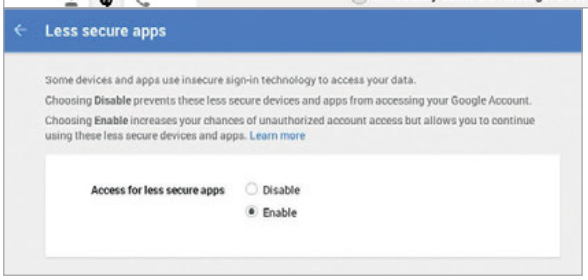
life.py

Language
>PYTHON

DOWNLOAD:
magpi.cc/2t3BAwb

```
#You can import any required modules here

moduleName = "life"

commandWords = ["meaning","life"]

def execute(command):
  print("\n")
  print("----------The meaning of life is 42----------")
  print("\n")
```




Less secure apps
Some devices and apps use insecure sign-in technology to access your data.
Choosing Disable prevents these less secure devices and apps from accessing your Google Account.
Choosing Enable increases your chances of unauthorized account access but allows you to continue using these less secure devices and apps. Learn more
Access for less secure apps
Disable
Enable

Above IMAP must be enabled so that SiriControl can fetch the new Notes using this protocol

Left Access for less secure apps needs to be enabled, as Google identifies this connection as being less secure

>STEP-06

Next steps

Now you know how to create your own voice commands, what next? Well, whether it's as simple as turning on an LED or controlling your TV using infrared signals – with the power of Siri behind it, the possibilities are endless! You could integrate SiriControl into any project. Due to the nature of the hack, you can control your Raspberry Pi from anywhere in the world, as long as you have an internet connection. This opens up many possibilities, including home automation and IoT. Anything is possible!

BEN NUTTALL

Raspberry Pi's Community Manager, creator of the GPIO Zero library, Jam master, and the Foundation's resident Python expert!
twitter.com/ben_nuttall

REMOTELY CONTROL GPIO WITH GPIO ZERO

GPIO Zero is a very powerful tool, and now you can use it when you're not even on the Raspberry Pi!

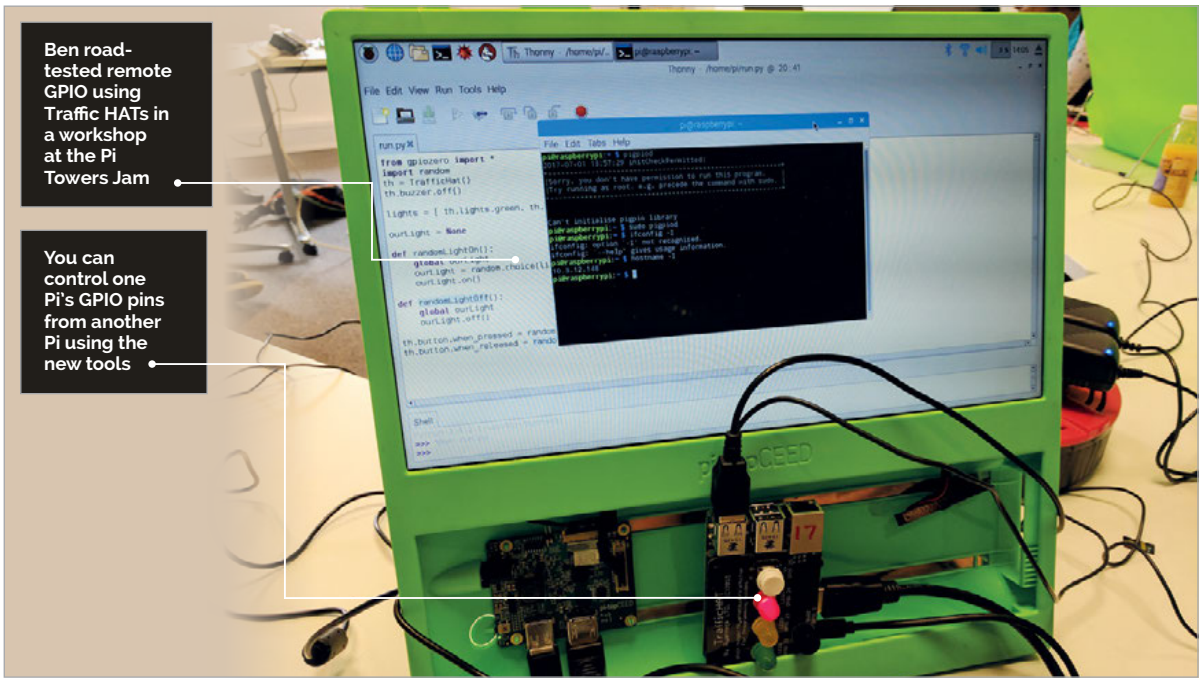
The GPIO Zero Python library not only makes programming simple electronics easier; it comes with some advanced features. These offer seamless interfacing between different devices, while helping you progress along the Python learning curve. One useful thing about GPIO Zero is that you can choose which low-level pin library to use, allowing you to take advantage of the power of another library as required, without having to rewrite your code. By default, Ben Croston's **RPi.GPIO** library is used, and that's fine for most purposes. One of the supported alternative libraries is Joan 2937's **pigpio** library, which supports remote GPIO. This allows you to remotely control the GPIO pins of a Pi over a network. You can control the pins from a PC or Mac, or from another Pi, and even use the GPIOs of multiple Pis within the same script.

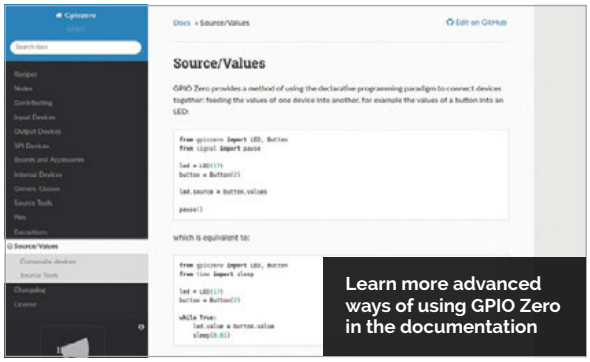
This month, GPIO Zero v1.4 was released, stabilising the remote pins syntax. This guide is written for v1.4 and will not work on earlier versions. Make sure you upgrade before you start: open a Terminal and enter **`sudo apt update && sudo apt install python3-gpiozero`**.

A simple GPIO Zero Python script looks like this:

```
from gpiozero import Button, LED
from signal import pause

btn = Button(2)
led = LED(17)

led.source = btn.values

pause()
```

Running this script on a Pi will work as expected: a button connected to pin 2 (BCM numbering) will light an LED connected to pin 17 when pressed. However, when configured correctly, running this same script can control the pins of a Pi over the network.


Ben road-tested remote GPIO using Traffic HATs in a workshop at the Pi Towers Jam
You can control one Pi's GPIO pins from another Pi using the new tools



Pin factories

The way GPIO Zero wraps around low-level pin libraries is by providing a pin factory. By default, an **RPi.GPIO**-based factory is used, and when you ask for a pin, the factory gives you a connection to it using the chosen pin library. A **pigpio** pin factory can be used on its own (simply use the **pigpio** library instead of **RPi.GPIO**), but if an IP address is provided too, this can be used to remotely control a Pi's pins.

To run the above script (unchanged) on a remote Pi, the Pi needs to be configured to accept remote connections. This can be done using the Raspberry Pi configuration tool (via GUI or **sudo raspi-config**), by enabling Remote GPIO under Interfaces. Otherwise, the Pi needs to have the **pigpio** daemon running, by entering **sudo pigpiod** in a Terminal. Finally, look up the Pi's IP address with **hostname -I**. Now return to the Pi you're running the script from, and instead of running the code normally (like **python3 led_button.py**), set two environment variables in the same command, using the remote Pi's IP address:

```
GPIOZERO_PIN_FACTORY=pigpio
PIGPIO_ADDR=192.168.1.5
python3 led_button.py
```

Now, when the script runs, the GPIO commands are executed on the remote Pi over the network.

An alternative to running a script from the command line is to set the environment variables before launching your Python editor. For example:

```
GPIOZERO_PIN_FACTORY=pigpio
PIGPIO_ADDR=192.168.1.5
idle3 &
```

You can also export these variables in your **.bashrc** file. See **magpi.cc/2qd2MEb** for more information.

Hot-swapping pin factories

The previous example showed how to set the default pin factory. Unless otherwise specified, any GPIO devices created will be connected to pins created by this default pin factory. Alternatively, you can specify a pin factory (and with **pigpio**, an IP address) within the Python code. There are two options for doing this.

You can create a pin factory instance, and pass that in as you create a new object, like so:

```
from gpiozero import LED, Button
from gpiozero.pins.pigpio import PiGPIOFactory
from signal import pause

factory = PiGPIOFactory('192.168.1.5')

btn = Button(2) # local RPi.GPIO pin
led = LED(17, pin_factory=factory) # remote pin

led.source = button.values

pause()
```

Alternatively, you can change the default pin factory in the middle of your script, like so:

```
import gpiozero
from gpiozero import LED, Button
from gpiozero.pins.pigpio import PiGPIOFactory
from signal import pause

btn = Button(2) # local RPi.GPIO pin
gpiozero.Device.pin_factory = PiGPIOFactory('192.168.1.5')
led = LED(17) # remote pin

led.source = button.values

pause()
```

Press the button on your Pi and watch the LED light up on the remote Pi. With no environment variables set, **RPi.GPIO** is used as the default pin factory. When the button is created, it uses **RPi.GPIO** to address a local pin. The default pin factory is replaced with **pigpio**, connecting to a particular IP address, and the LED is created on pin 17, which now refers to the remote Pi.

While this can be a confusing concept, it's quite simple once you get used to the idea, and it could be very useful in many projects. You can even run this code on a PC (not a Raspberry Pi) and use it to control a Pi on the network. Any platform (Windows, Mac or Linux) will work, as long as you have Python, **pip**, **GPIO Zero**, and **pigpio** installed. For full instructions, head over to **rpf.io/remotegpio**.

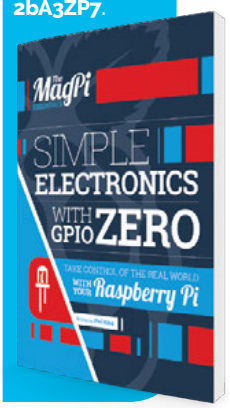
Security

It's worth pointing out that allowing remote GPIO connections over the network can be risky. You probably shouldn't do this in a real project on a network with other users. However, you can take precautions to make it more secure. An easy method is to only allow remote connections from a particular IP address when launching the **pigpio** daemon: **sudo pigpiod -n 192.168.1.4**.

Check out some remote GPIO recipes and more on the GPIO Zero documentation at **magpi.cc/2qd2MEb**.

LEARN MORE ABOUT GPIO ZERO

GPIO Zero is an amazing tool for creating simple electronics and making your projects just that little bit easier. Check out our Essentials book, *Simple Electronics with GPIO Zero*, to learn more: **magpi.cc/2bA3ZP7**.



FREQUENTLY ASKED QUESTIONS

Your technical hardware and software problems solved...

NEED A PROBLEM SOLVED?

Email **magpi@raspberrypi.org** or find us on **raspberrypi.org/forums** to feature in a future issue.

RASPBERRY PI CARE

HOW CAN I KEEP THE RASPBERRY PI SAFE?

Get a case

The Raspberry Pi is pretty sturdy as a board, but getting a case makes sure it's even hardier. A case will help protect it from dust and accidental placement on a metal table. Numerous inexpensive cases are available, including the official versions (**magpi.cc/2tb49Zm**) and some fun layered cases from Pimoroni (**magpi.cc/2urDcRn**).

Choose a suitable environment

Like a can of beans, you should keep the Raspberry Pi in a cool, dry place. If you want to place it on a windowsill in southern California, it will be fine, but it probably won't last as long as one kept in the shade.

Turn it off

If you have a Raspberry Pi that doesn't need to be on 24/7, it may be a good idea to turn it off when you're not using it. It draws very little power, so you can keep it on for long periods of time if you need to.

Below The official Raspberry Pi case

HOW CAN I KEEP RASPBIAN RUNNING SMOOTHLY?

Low maintenance

Unlike Windows, Raspbian should run smoothly all the time if you're just using it to do the odd Raspberry Pi project. Its Linux base runs differently to Windows, so it doesn't become 'bloated' in the same way.

Uninstall redundant software

If you've installed a piece of software for a specific project that you no longer need, it may be a good idea to remove it. Some software will add extra background services to Raspbian, and they'll grow to take up more computing resources, especially if it's an internet-based project.

Desktop or command line?

Depending on how you use your Raspberry Pi, it may be useful to set Raspbian to boot to the command line instead of the desktop. You can change the boot settings in Menu > Preferences > Raspberry Pi Configuration, where you can also choose whether or not to log in automatically.

HOW DO I KEEP MY FILES SAFE?

Cloud storage backup

Keeping your more important files on Dropbox or another cloud storage service is a good idea. You can set up Dropbox on Raspbian to sync files, which will also allow you to access them easily on another computer.

SD card backup

Be sure to make copies of your SD card, especially if the setup is complex and may need to be replaced quickly in an emergency. Check our troubleshooting guide (starting on page 16 of this issue) for information on how to do this.

Change passwords

Raspbian uses a standard default user name and password, so if you need to have your Pi open to SSH and keep your files secret, you'll want to change the password. This guide will show you what to do: **magpi.cc/2iqm9pO**.

FROM THE RASPBERRY PI FAQ
RASPBERRYPI.ORG/HELP

CAN I BUY A RASPBERRY PI KIT?

Raspberry Pi resellers produce some fantastic bundles for people who would rather get everything they need from a single source. Last year, The Raspberry Pi Foundation put together an Official Starter Kit. The kit is available to order online in the UK from its partners, element14 (**magpi.cc/2cCT8pk**) and RS Components (**magpi.cc/2nrY33i**), priced at £99+VAT, and from distributors and resellers around the world.

IS THERE A BUY-ONE-GIVE-ONE PROGRAMME?

Not at the current time. Raspberry Pi may implement a gifting programme one day, but at the moment the Foundation's small team isn't equipped to handle the scale of an undertaking like this. You can, of course, simply buy an extra Raspberry Pi to donate to the person or organisation of your choice.

IS THE DEVICE AVAILABLE INTERNATIONALLY?

Yes. Take a look at the official resellers that ship internationally, or check out your local big electronics chain.

I WANT TO BE A RASPBERRY PI RESELLER

Raspberry Pi has an exclusive manufacturing and distribution arrangement with RS and Farnell. Resellers buy the Raspberry Pi in bulk from them (which reduces shipping costs to nearly nothing) and sell them on. You do not need any special licence to resell, and the distributors are very happy to sell on to resellers. Unfortunately, because of the way the pricing model works, and the fact that the Foundation is a charity, you will have to buy in very large quantities before you will qualify for any bulk discount. What most resellers are doing is using the resale process as a way to sell high-margin peripherals and add-ons.

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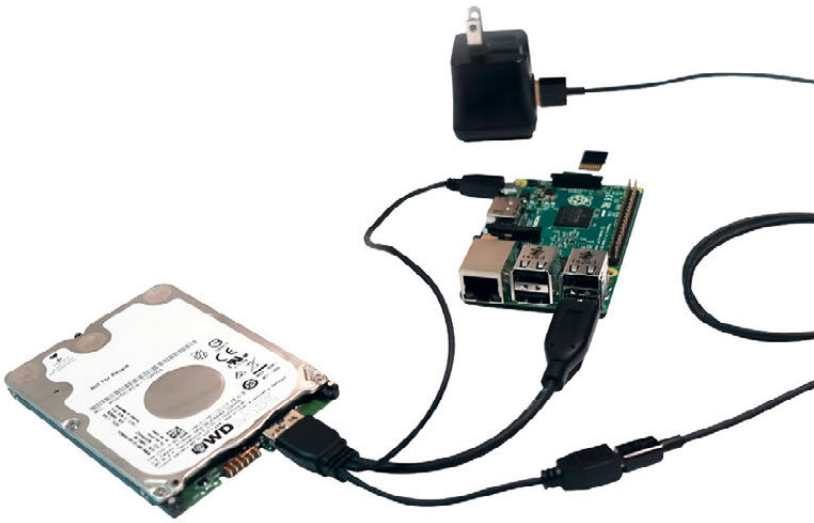

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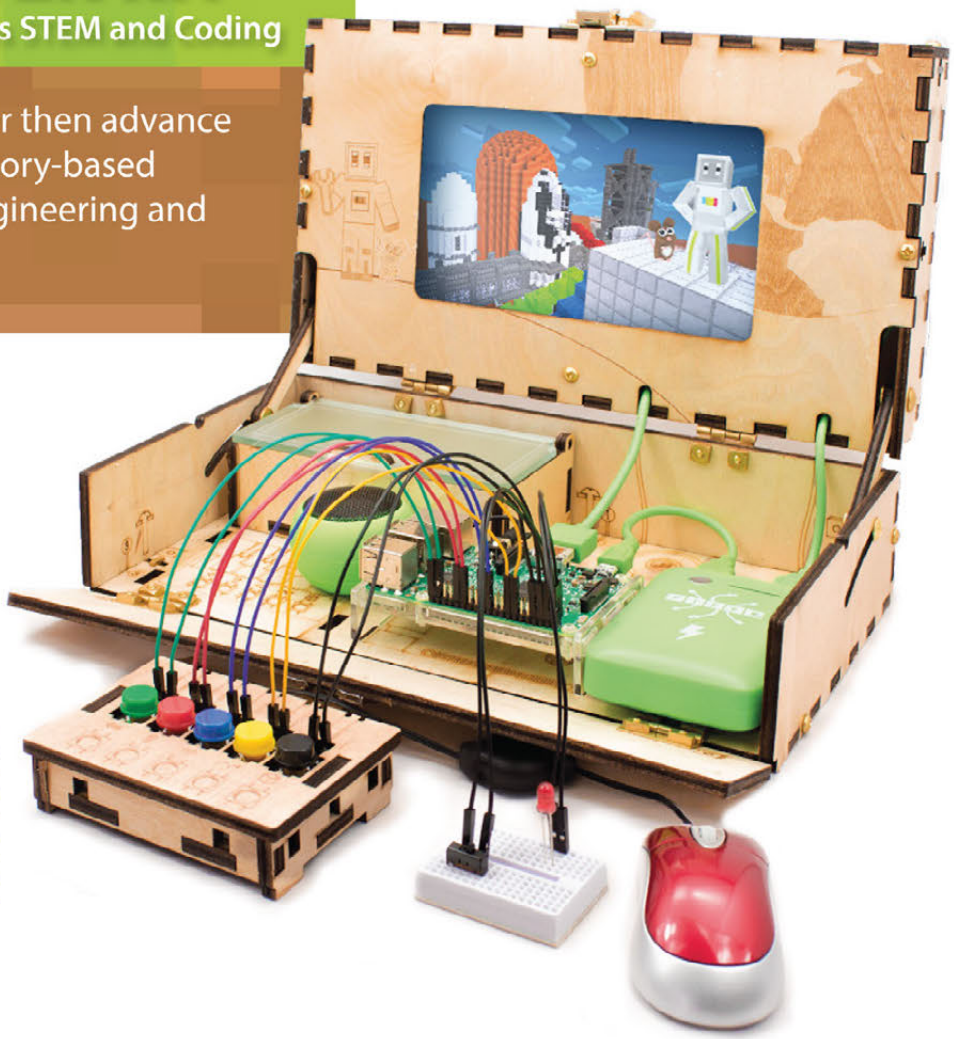

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Get Creative

Incredible creative techniques and inspirational art projects for Raspberry Pi

The Raspberry Pi is beloved by artists and seriously creative people. These digital makers are building the future, but they're also building superb works of art. In galleries around the world, you'll find Raspberry Pis quietly tucked away inside incredible art installations. The small size and low power usage of the Pi make it ideal for public installations. Raspberry Pi boards can control movement, light, sound, and vision. Just as importantly, they can provide a layer of interaction between the audience and the artwork.

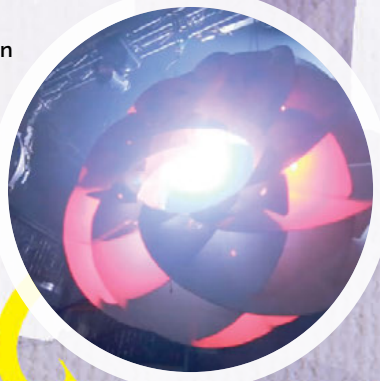
Raspberry Pi–powered art is often more interesting to the public because they can interact with it on their own terms. The results are some of the most creative projects on Earth. We've featured a lot of artistic projects in The MagPi, mostly because they show off some creative use of the common technologies applied by digital makers.

In this feature we'll look at some common techniques used by artists incorporating a Raspberry Pi into an installation. Learning these techniques can help you to integrate a Raspberry Pi into your project. Even if you don't see yourself as an artist, creating something is a great way to learn about a particular feature or element of the Raspberry Pi.

The intersection of visual art and technology is one of the most exciting places to be, and the Raspberry Pi is right at that point. Let's look closer at Raspberry Pi art to see what we can make.

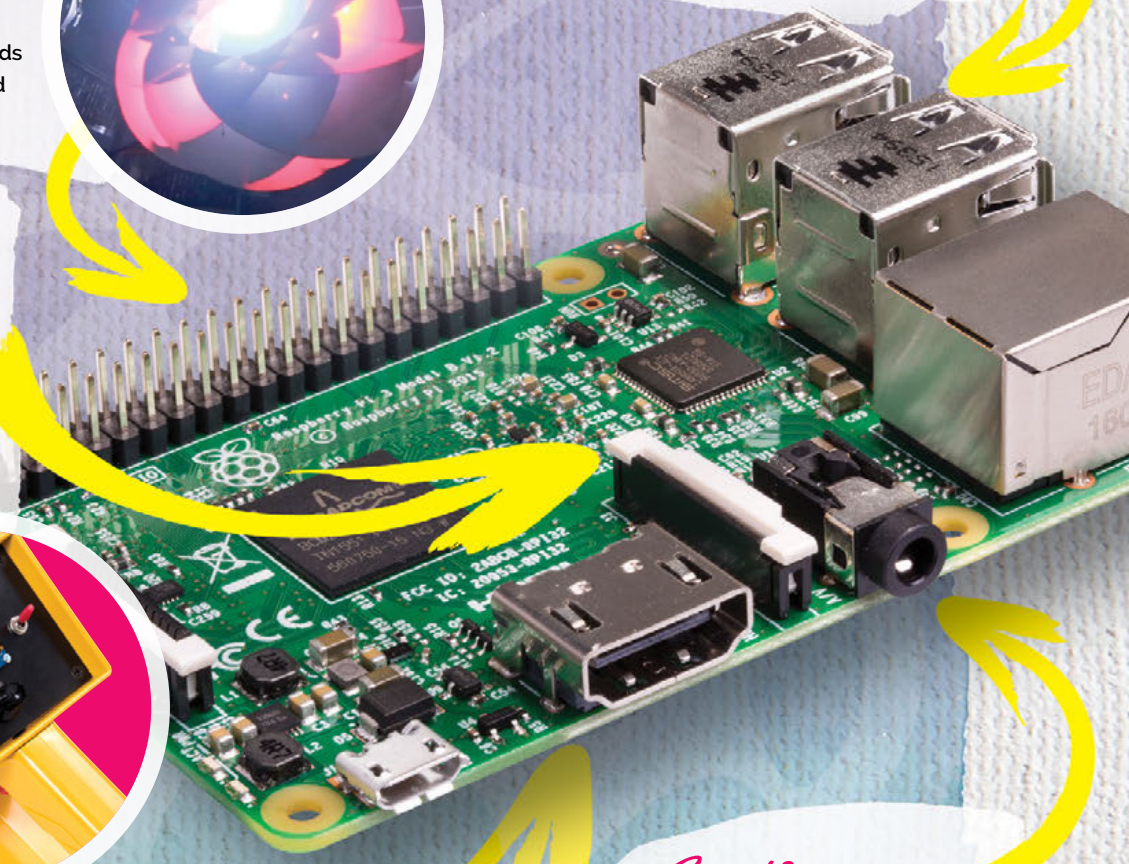
Input and output

You can connect a wide range of sensors and input devices to the GPIO pins, and also use them to control motors and LED strips. TORUS is a music installation piece created by Dutch visual artists Ridwan Nasruddin and Guust van Uden (**magpi.cc/2aWdy9e**). It is a large geometric shape, covered in hundreds of LEDs, controlled by a Raspberry Pi.



Wireless and Ethernet connectivity

The built-in Ethernet and wireless networking connection can be used to link your creation to the internet for interesting data-driven artworks. Cory Guynn's Internet of LEGO project (**internetoflego.com**) is a giant LEGO sculpture connected to the Transport for London API, recreating the commuter world on a small scale.

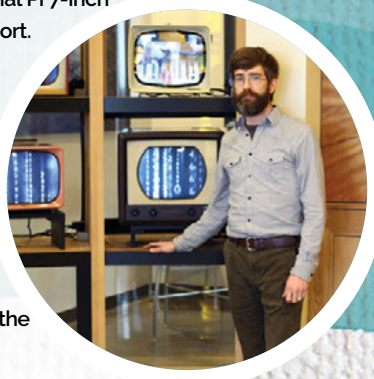


Camera Module

The built-in connection for the Camera Module makes it easy to add still photography and video recording using a Raspberry Pi. The Trophy Camera project (**magpi.cc/2t6ZiZn**) is a great example of an art installation that uses the Camera Module. Visitors to the Tetem gallery in The Netherlands use it to take photographs, which are then deemed award-worthy (or not) thanks to its AI intelligence algorithm.

HDMI video

The HDMI socket enables you to stream 1080p video at 60 fps. You can also connect an official Pi 7-inch touchscreen to the DSI port. It's easy to add video to your creative Pi projects. The #GMPiWall video installation (**magpi.cc/2tiSxPr**) uses old TV sets retrofitted with Pis. Built by Joseph Hazelwood, #GMPiWall appeared at the Oz Arts Fest.



Audio out

The 3.5 mm audio jack can be used to output sound from the Raspberry Pi. Or you can add a DAC (digital to analogue converter) board for higher-quality audio. Lichen Beacons (**magpi.cc/2tPnw7t**) is an interactive sound installation that uses portable Raspberry Pi and Bluetooth beacons to play music and poetry as visitors walk around an attraction.

Visual Art Skills

Basic skills you'll need to integrate a Raspberry Pi into your art projects

A Raspberry Pi can give you the opportunity to explore participation and interaction in your digital creations. The Raspberry Pi makes it easy to add video and sound to a creative space, and you can connect this up with sensors and interactive elements, such as buttons or controls. This setup lends your artistic experiment a much greater level of engagement with the audience.

Loop video

Probably the first skill you want to learn is how to loop video. Raspbian comes with Omxplayer, which can play video from the command line. It also features a handy loop option.

```
omxplayer -b --loop --no-osd video.mp4
```

This will play the video repeatedly on a blank background, and remove the on-screen display (which by default shows the play time on the screen).

You can also run the video at startup, so it plays as soon as you plug in the Raspberry Pi. A quick hack is to add a command to **.bashrc** in your home folder.

```
nano .bashrc
```

Add:

```
omxplayer -b --loop --no-osd /home/pi/video.mp4
```

…to the end of **.bashrc** (replacing 'video' with the name of your file).

Save and reboot. Note that this will boot automatically and you won't be able to get out of the video. Pressing **ALT+F1** will enable you to open another command-line shell, where you can edit or remove the line from **.bashrc**.

It's also a good idea to enable SSH and ensure that you can access your Raspberry Pi remotely when running looping video. A much more detailed, and effective, script can be found on the Raspberry Pi forum (**magpi.cc/2uJiuJz**).

Loop still images

The best way to loop still images on a Raspberry Pi is to use a screensaver. You'll need to install one first, using two apps: **feh** and **XScreenSaver**.

```
sudo apt-get update && sudo apt-get upgrade
sudo apt-get install feh xscreensaver
```

Virginia Tech's *SeeMore* sculpture uses servo motors to move its 256 Raspberry Pi boards

From the Raspbian desktop Menu (top left), select Preferences > Screensaver and set Blank After to 720 minutes. This will allow the screensaver to run for 12 hours. Place all your image files in a directory called **media** in the home directory and run this command:

```
feh -Y -x -F -Z -q -B black
-D 10 /home/pi/media
```

The **-B** option changes the background colour, while **-D** sets the length (in seconds) before the next slide.

Playing audio

You can play audio on a Raspberry Pi using Omxplayer:

```
omxplayer example.mp3
```

If you need an example file, you can download one with this command:

```
wget https:@goo.gl/XJuOUW
-O example.mp3 --no-check-
certificate
```

You can force output to the HDMI socket or headphone jack using the **-o** option:

```
-o hdmi
-o local
```

Use **--loop** to loop the audio and **--no-osd** to remove the on-screen display.

```
omxplayer -o local --loop
--no-osd example.mp3
```

The Trophy artwork installation uses a Raspberry Pi and Camera Module with AI technology. Visitors try to capture award-winning photographs using the camera

Live-coding synth

Raspbian comes with a live-coding synth program called Sonic Pi (**sonic-pi.net**). With Sonic Pi you can code original synth scores, and there's a huge range of samples. It's particularly good for creating ambient sound effects (everything from haunted bells to *Tron* bikes).

There's more to Sonic Pi than we can cover here, but make sure you pick up a copy of *Code Music with Sonic Pi* (see sidebar).

Add interaction

Adding interaction to a piece is the reason many artists pick up a Raspberry Pi in the first place.

Wiring up buttons and sensors to a Raspberry Pi couldn't be easier. You can use a breadboard to test out your electronics, and then solder the circuit into your creation. It's a big topic, but the process is a lot easier than you think. See our *Simple Electronics with GPIO Zero* book in the sidebar for details on how to get started.

You can also use the GPIO pins to control LED strips, such as Blinkt! (**magpi.cc/2uRAXnp**). These add high-tech colour to a creative project.

Don't forget that Raspberry Pi makes an official touchscreen (**magpi.cc/2ufft6Y**). This can be used to add a small display to your creations, which observers can push and touch. With a bit of coding, you can create your own interface (see *Getting Started with GUIs* in The MagPi #58, **magpi.cc/2t6979S**).

Motion control

In our *Simple Electronics with GPIO Zero* book, you'll also find detailed info on using servos and motors. These make it possible to add movement to your creative projects.

Servos are special motors that drive precise circular movements. The rotating parts can be extended to create clock-like precision elements or limb-like gestures.

DC motors provide continuous circular motion. They can be used to add fans, wheels, or other rotating elements to your creative project.

Creative Essential Guides

Code Music with Sonic Pi

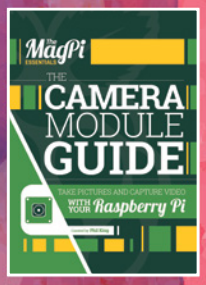
If you want to learn how to add ambient sound or music to your art project, grab a copy of *Code Music with Sonic Pi*: **magpi.cc/1VGIOux**.

GPIO Zero

GPIO Zero is a simple Python interface for controlling electrical items, including LED lights, sensors, servos, and motors. Check out *Simple Electronics with GPIO Zero* (**magpi.cc/2bA3ZP7**) for details on adding electronic components to your creations.

Camera Module Guide

Our *Camera Module Guide* (**magpi.cc/2ufdjnT**) is a fantastic resource for learning how to integrate the Pi Camera Module into your projects.



Cameras

The Raspberry Pi Camera Module is a good addition to some projects. It enables you to capture stills and video, which can become part of the artistic project, or shared online. Take a look at the Photo Booth project on page 30.

The Trophy Camera featured in The MagPi #58 (**magpi.cc/2t6yKay**) is a great example of an installation that uses the Camera Module.

Introduction to Processing

Get started with the key programming language used in visual arts

Processing is an open-source development environment and programming language, designed for learning to code. While it is very flexible and powerful, it is mainly used in the realm of visual arts.

Processing allows you to use code to create drawings on screen. The language is certainly capable of much more than that, but this tutorial will focus on drawing.

To install Processing, visit **processing.org/download** and download the Linux ARMv6hf version. Enter this in the Terminal:

```
tar xvfz processing-3.3.5-linux-armv6hf.tgz
cd processing-3.3.5/
sudo ./install.sh
```

To start Processing, click on Menu > Programming > Processing. The main Processing window is where you'll type your code, and the Run button is how you'll execute that code. In the world of Processing, the program you write is called a sketch. To create your first simple sketch, enter the following code:

```
line(0, 0, 100, 100);
```

Now click Run. A new window should appear, showing a box and a diagonal line. The line function draws a line between two points in the window. It takes four inputs: **x1** and **y1** for the start of the line, and **x2** and **y2** for the end of the line. The syntax for the line function is:

```
line(x1, y1, x2, y2);
```

The numbering begins at 0, not 1. Also, the origin is in the top-left, rather than the bottom-left. See **Figure 1**.

You can do a lot with lines, but Processing can draw plenty of different shapes. Enter the following code in a blank sketch and press Run:

```
ellipse(50, 15, 30, 30);
```

The **ellipse** function draws an ellipse (oval). An ellipse with equal width and height is more commonly known as a circle. The syntax for the **ellipse** function is:

```
ellipse(xPosition, yPosition, width, height);
```

Try using the **line** function to draw the rest of a person. Here's a hint to get you started:

```
ellipse(50, 15, 30, 30);
```

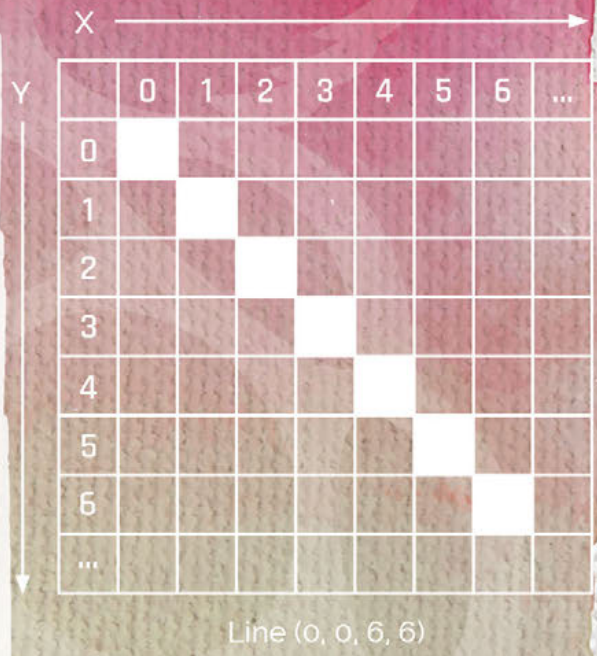


Figure 1 The coordinates system in Processing moves right and down, rather than right and up as in traditional Cartesian coordinate systems

Top Tip

Check examples

Explore the example code that's included with Processing. Click File > Examples to open the example browser.

```
line(50, 30, 50, 70);
```

You can draw a rectangle using four **line()** commands, but there's a rectangle function, **rect**, to make it easier. Its syntax is:

```
rect(xPosition, yPosition, width, height);
```

Try drawing a box around your stick figure. At this stage, it's important to note that as your code is executed, Processing draws shapes on top of previously drawn shapes. You may want to execute the **rect** function before the code that draws your stick figure.

Language
>PROCESSING

DOWNLOAD:
magpi.cc/picreative

The program is packed with examples of quirky artworks based on fractals, waves, and other scientific concepts

Add colour to your shapes

There are many ways for us to describe colours to a computer. With Processing, you'll usually use an RGB value, which describes colours by stating how much red, green, and blue are in them.

To try it out, run the following code to draw a circle with a red fill:

```
fill(255, 0, 0);
ellipse(50, 50, 75, 75);
```

After you call the **fill** function, any shapes drawn after that function will have that colour fill, until you call the **fill** function again with a different colour. The syntax for **fill** is:

```
fill(red, green, blue);
```

Each primary colour can be given a value of 0 to 255. 0 means no presence of the colour, and 255 is the maximum amount of that colour.

To change the colour of the outline, use the **stroke** function. It uses the same colour parameters as the **fill** function:

```
stroke(red, green, blue);
```

If you want to get rid of the stroke or fill, use the **noStroke** and **noFill** functions. Keep in mind that if you use them both at the same time, you won't be able to see what you're drawing!

By default, all lines are one pixel wide. To increase the thickness of the line, use the **strokeWeight** function. As with the colour functions, after you call it, all the shapes you draw will have your specified thickness until **noStroke** is called, or **strokeWeight** is called with a different value. The syntax is:

```
strokeWeight(width);
```

Respond to input

To create movement, you'll need to define two special functions: **setup** and **draw**. The code you write in the **setup** function is only executed once, when your sketch starts. Afterwards, the code in the **draw** function is executed over and over again until you terminate the sketch. This is the basic structure of most of the Processing sketches you'll write:

```
void setup() {
    @ the code here will
only be executed once.
}
```

```
void draw() {
    @ the code here will
be executed over and over
again.
}
```

Enter the code from **circle.pde** into a new Processing sketch and run it. The pieces of text after the double slashes are comments to help you understand what each line is doing; they'll be ignored by Processing.

You should see a circle moving downwards. When it gets to the bottom, it resets to the top again. It will move like this forever.

The code in **processing.pde** uses a few special variables that all Processing sketches have built in: **height**, **width**, **mouseX**, and **mouseY**. The **height** and **width** variables refer to the height and width of the window. The **mouseX** and **mouseY** variables contain the position of the mouse pointer.

You also used the **height** variable in the previous sketch, to check the position of the circle in relation to the bottom of the window.

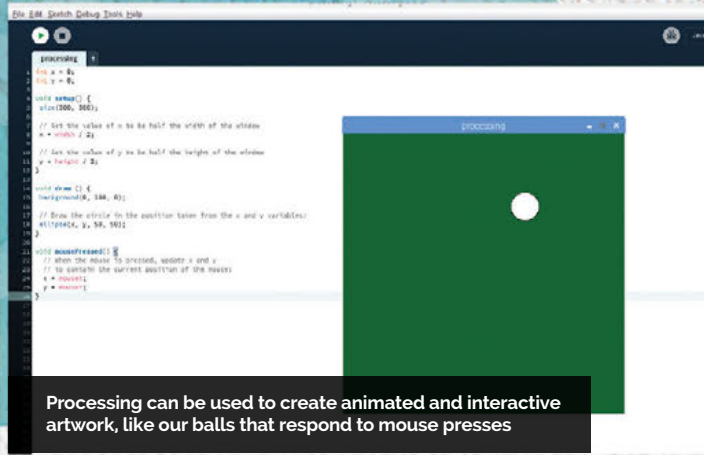
The code also creates a special function called **mousePressed()** that is executed when either mouse button is pressed. This is an example of 'event-driven programming'.

These are just the basics of drawing on screen using code; there are many more functions to try. You can see a list of functions in the Reference section at **processing.org**.

Top Tip

Find help

If you ever forget how to use a function, you can always right-click on it in your code and click on Find in Reference. This will open a local copy of the Processing reference for that function.



Processing can be used to create animated and interactive artwork, like our balls that respond to mouse presses

Inspirational Art Projects

Stuck for ideas? Take a closer look at how these art projects use a Raspberry Pi to add interactivity and technical wonder

Sisyphus

Draw lines in the sand with a robot-controlled magnet

Techniques
DC motor control, path files, robotics, Node.js

Created by
Bruce Shapiro

More info
sisyphus-industries.com

The kinetic sculptures are drawn in sand by Sisbot, a robot with two DC motors that sits under the table

Bruce Shapiro is a maker and an artist. Unlike Picasso or Rembrandt, Bruce doesn't paint with oil and brushes. "My medium is motion control," he told us in The MagPi #52 (**magpi.cc/2tPgS14**).

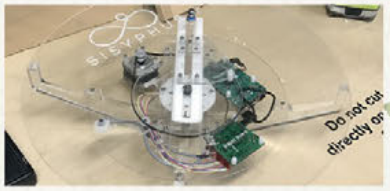
"In Greek mythology, Sisyphus was condemned to roll a boulder up a mountain for all eternity," says Bruce. "In my art, *Sisyphus* is a kinetic sculpture that rolls a ball through sand, forever creating and erasing beautiful patterns. Watching Sisyphus evokes a meditative feeling."

Under the table is a two-motor robot called Sisbot. This moves a magnet which pulls the steel ball (sitting above the sand). The motors of the Sisyphus are controlled by a Raspberry Pi. This plays a set of path files, much as a music player plays an MP3 file.

At the lowest level, the Sisbot is controlled by "firmware written in C, running on the SisBotBoard". This was created by Brian Schmalz (**magpi.cc/2t74z37**) for an earlier project Bruce created called EggBot. "Brian started many years ago with the initial crude C code I wrote for running my steppers," Bruce explains.

The second level is higher-level motion control, recently ported to JavaScript by Bruce and cleaned up considerably by Alex Wayne. This code runs in Node.js on the Raspberry Pi.

The third level is algorithmic path generation. "I originally did this by writing using AutoLISP routines running in vintage AutoCAD," says Bruce, "but now I use Grasshopper Rhino 3D."



Above The Sisbot works like a CNC cutter, moving the magnet around in circles while the arm moves up and down

Digital Zoetrope

Learn how to integrate displays into your creations with this unique high-tech recreation of a design classic

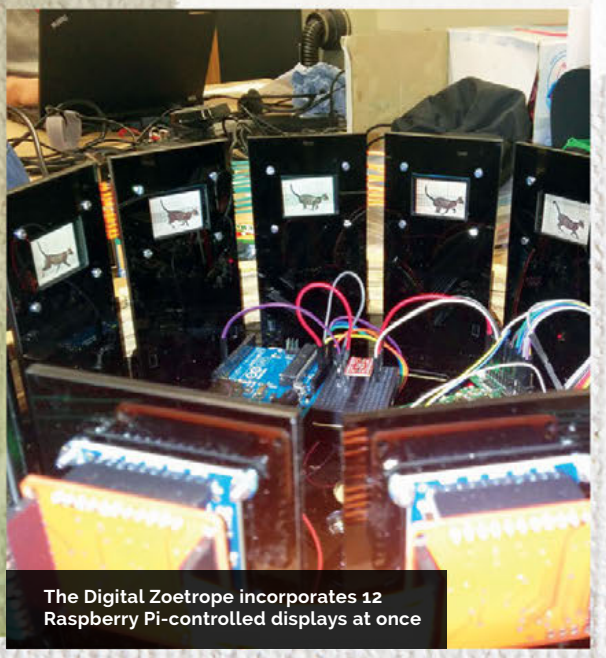
Techniques
HDMI display integration

Created by
Brian Corteil

More info
magpi.cc/2cotnva

Brian Corteil's *Digital Zoetrope* replaces the photos on the inside with 12 OLED displays. Like a classic zoetrope, you spin it around by hand and look through the slats to see movement in the still images as they rotate. It can project still images to create a classic 12-frame short, or update the frames in real time to produce a longer movie.

It's a good example of incorporating digital images into a project, and ranked #27 in our readers' Top 50 projects of all time. You can read more about it in The MagPi #50 (**magpi.cc/2t6Rvul**).



The Digital Zoetrope incorporates 12 Raspberry Pi-controlled displays at once

SeeMore

A moving Raspberry Pi sculpture that's secretly a supercomputer

Techniques
Servo motor control, CNC, laser etching

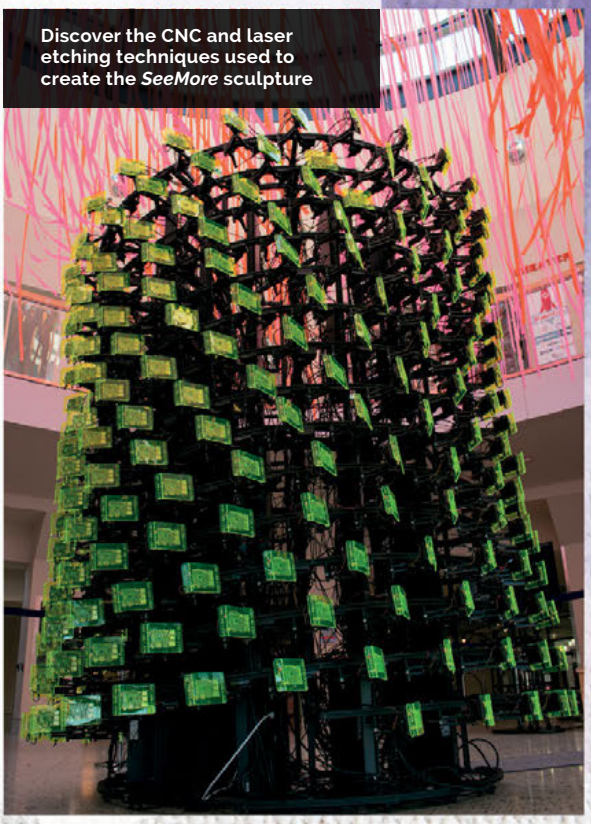
Created by
Virginia Tech

More info
seemoreproject.com

Virginia Tech's *SeeMore* uses 256 Raspberry Pi boards to create a massive fusion of tech and art. It was designed to inspire a sense of the beauty of parallel computing.

A lot of the parts were custom-made via CNC and laser etching, so there's a lot you can learn about electronic sculptures with *SeeMore*. But the coolest thing about the piece is how the panels covering each Pi move depending on how much computational power is being used. These are moved using servo motors, so it's an inspirational way to add gentle movement to a project, controlled by a data point.

SeeMore came second in our readers' Top 50 (**magpi.cc/2t6qOpH**).



Discover the CNC and laser etching techniques used to create the *SeeMore* sculpture

Voyage

Discover interactivity by following Voyage's lead

Techniques
DHCP and web server interaction

Created by
Aether & Hemera

More info
magpi.cc/2d3mGfC

Voyage is an impressive art installation that's toured the world, appearing in London and Salford Quays in the UK.

Conceived by Newcastle-based studio Aether & Hemera, the art project is made from coloured paper boats floating on water.

There's a Raspberry Pi acting as a DHCP and web server as part of the control mechanism, and it's a great example of how you can add public interaction to a project. Viewers engage with the lights from their mobile phones.

The *Voyage* art installation reacts to public interaction by changing the colours of its lights

QBee

Add LED lighting to a project

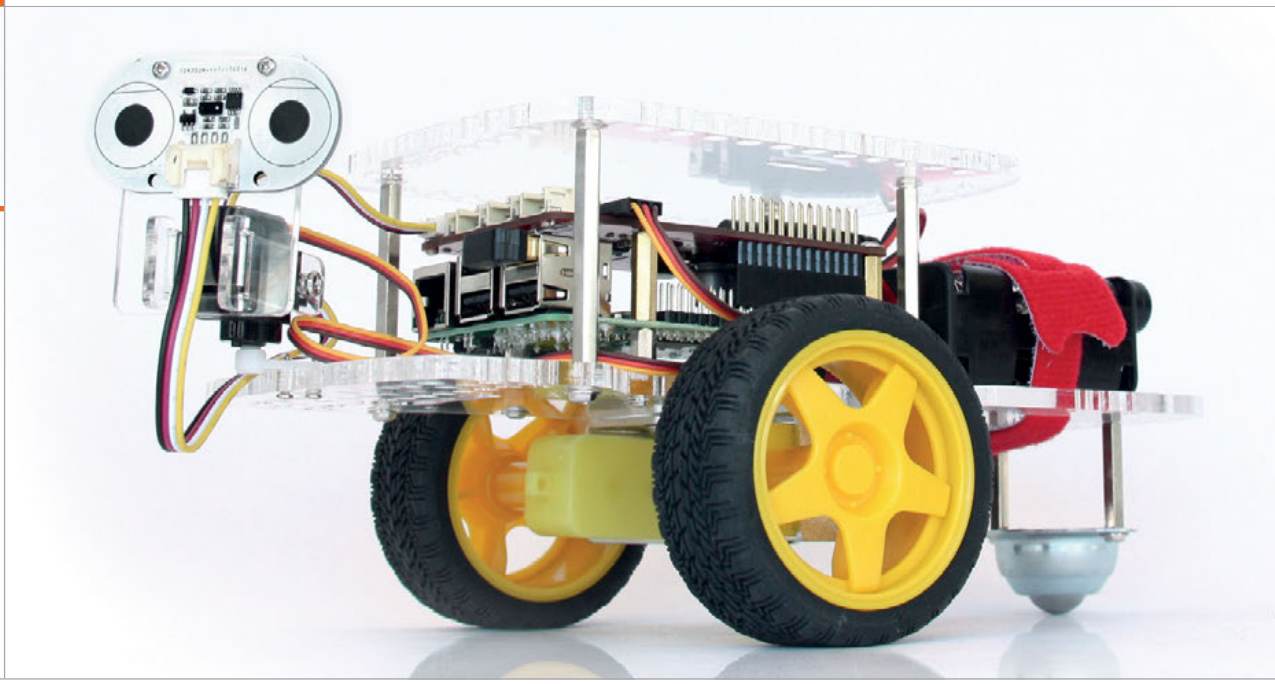
Techniques
LED fibre optics, capacitive touch

Created by
Clodagh O'Mahony

URL
magpi.cc/2t6EMIe

Clodagh O'Mahony designed a wearable connected platform that is a comment on the progression of social media interaction. The *QBee* dress incorporates an Adafruit 12-key capacitive touch sensor breakout board, Pimoroni Blinkt! fibre optics, and a Raspberry Pi, all fitted inside a hexagonal 3D-printed casing. The fibre optics are woven throughout the dress.

The *QBee* dress features touch-sensitive pads and has LED fibre optics woven into the fabric



Maker Says

"A complete kit to build your own robot car"

Dexter Industries

GOPIGO3

Sturdy robot kit creates a network and broadcasts lessons, making it ideal for students and teachers alike

For the last couple of years, the GoPiGo has been one of the most impressive robot kits available for the Raspberry Pi.

The build remains excellent for the latest version. Two 3D-printed acrylic boards house a Raspberry Pi 3 and GoPiGo3 board. To this, you attach the motors, a wireless networking dongle, a battery pack, and a USB thumb drive.

The build of the robot is relatively complex (although with fewer steps than the GoPiGo2 kit it replaces). It took us 45 minutes to put in all the screws, washers, and posts that connect the various parts together. This build time is about three times as long as most kits we encounter.

There are good photographic instructions, though, and we didn't get stuck during the build process. More information on the build process can be found at **magpi.cc/2v08oVo**.

You might be wondering why it comes with a wireless dongle when the Raspberry Pi 3 has wireless built in. That's because GoPiGo3 broadcasts its own wireless hotspot, so the minute you switch it on, you can connect to it via a local network called **GoPiGo**.

Thanks to this approach, as soon as you've finished the setup and inserted the eight batteries, it becomes an absolute breeze to start using the GoPiGo3. There's a whole new DexterOS operating system to play with and it's packed with features.

Hotspot robot

The robot transmits its network called **GoPiGo**. You connect to this network, and point a web browser to **bloxter.com**. You don't need internet access to do this. You can log into the network from a Windows, Mac, or Linux computer; a tablet or smartphone; and of course, another Raspberry Pi.

The web interface starts with four options: Drive, Learn, Code in Bloxter, and Code in Python. Click Drive and you can move the robot around using the on-screen buttons. Tap Code in Bloxter and you can use Scratch-style blocks to control the robot. The Code in Python option lets you use a web-based Python IDE to program the robot with the GoPiGo3 software library (GitHub, **magpi.cc/2tWzmwE**).

You can use Scratch to control the GoPiGo, but you need to switch the OS over to Raspbian for Robots. We think DexterOS has the better solution with Bloxter and Python. Based on Google Blocky (**magpi.cc/2uq6MG9**), Bloxter is similar enough to Scratch.

On the whole, DexterOS is a slick solution that enables you to

Related

CORETEC TINY 4WD

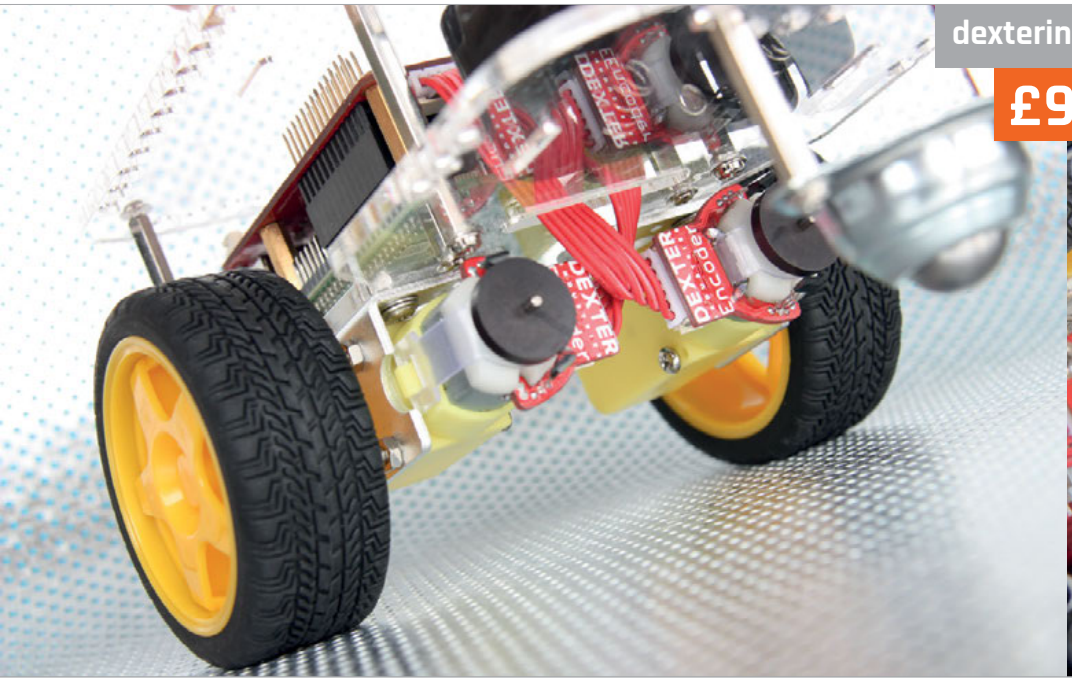
With twice as many wheels for around half the price, this new Pi Zero W based robot is a capable rover.

£55 / $70

magpi.cc/2r8e7oS

dexterindustries.com

£95 / $99



start controlling and programming the robot quickly. Perhaps more importantly, it combines the lessons and programming environment into one single space that doesn't require an internet connection – the robot acts as a router. There are dozens of lessons covering movement, sensors, speakers, buzzers, and buttons.

Ready to teach

There's a lot here for teachers. The GoPiGo is a great tool for introducing robotics to a classroom. It's relatively easy to set up, very easy to connect to from a wide range of computers, network independent, and packed full of tutorials for visual and text-based programming environments.

The two motors have encoders built in, so you no longer have to attach these separately during the build. These act as tachometers, measuring the precise rotation of the wheels. The GoPiGo3 runs forward and backwards in a straight line, can move by precise amounts (such as 10 cm or 5 in), and turn with degree precision. It's a small thing that makes a massive difference to the experience of using a robot.

There is a GoPiGo base kit for just $99. It includes the GoPiGo3 board, chassis, wheels, motors, encoders, and power battery pack. You need to add your own Raspberry Pi 3.

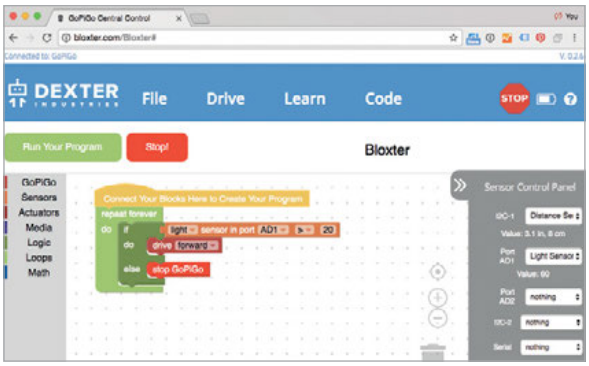
We tested the $199 Starter Kit, which comes with a Raspberry Pi 3, mini WiFi dongle, GoPiGo servo package, distance sensor, microSD card (with DexterOS software), 8GB USB drive, and power supply. It's a useful complete package, but we think the base kit would be sufficient if you already have many of the components.

The 8GB USB drive is used to update the software. You add software updates to the USB drive, power up the GoPiGo robot, and it automatically updates its software (see **magpi.cc/2t1QOyr**) – again, without the need to remove the SD card or connect to a network.

Both kits will be available soon in the UK from ModMyPi (**magpi.cc/2tTWJqN**).

Dexter offers a range of accessories for the GoPiGo. The Starter Kit comes with a servo motor and distance sensor, but you can also add an ultrasonic distance sensor, sound sensor, buzzer, temperature and humidity sensors, camera, and line follower. You can find tutorials for each of the sensor projects at **magpi.cc/2v08oVo**.

There's a lot about this robot that makes it ideal for the classroom. Aside from the integrated lessons and programming environment, it's a sturdy build. We'd wager it can take quite a few knocks.



Above Control the robot's movements using Bloxter

Even if you're not a student or a teacher, it's a great robot kit. The built-in encoders make it more accurate than other robots, and there are plenty of holes on the board for adding your own custom equipment. We've got a lot of time for GoPiGo3, and we intend to spend a lot of time experimenting with it. Well done Dexter!

Last word

One of the best robotics kits you can buy, especially for teachers. DexterOS is delightful, bringing programming and learning into one space. Creating its hotspot frees the robot from network limitations.

★★★★★

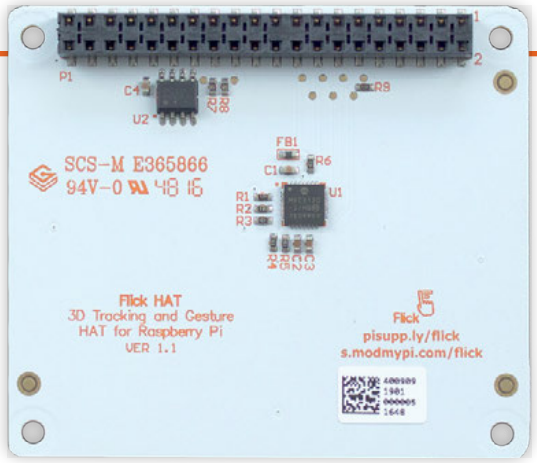
magpi.cc/2toNhLG

£20 /$28

Maker Says

"Swipe, tap or flick your wrist to control your Raspberry Pi"

Pi Supply



FLICK HAT

One of a trio of 3D gesture-tracking boards for Raspberry Pi computers

What could be cooler than triggering actions with a mere wave of your hand? The Flick HAT allows you do this, and more. The Flick HAT is one of three new 3D gesture-tracking boards – there's also a smaller Pi Zero version, and a larger stand-alone pre-soldered board with jumper leads to connect it to the Pi's GPIO header.

After securing the Flick HAT to the top of the Pi with the nylon nuts, bolts and spacers supplied, and then using a single-line installer for the software, it's ready to use.

It's a shame there are only three basic demos supplied, although a full Python API is in the works. The first demo shows the X, Y and Z values as you move your hand above the board, and it works best when you use a downward-pointing finger. While the blurb claims a vertical range of up to 15 cm, in our tests we typically achieved 5-7 cm. This distance will depend on the surroundings, and how conductive you are.

As well as tracking 3D positions, the board reads gestures including swipes (left-right and up-down), and 'airwheel', which involves rotating your finger in mid-air. This is ideal for an audio volume control, as used in the **volctrl** demo. Among many other uses, the swiping actions would be suitable for controlling a slideshow presentation – something we covered back in issue 39 using the rival Pimoroni Skywriter HAT (**magpi.cc/1PLLYMt**).

The Skywriter and the Flick are based on the same MGC3130 3D tracking chip. Not surprisingly, their performance is very similar. The chip reads up to 200 positions per second, enabling it to reliably detect simple gestures. Like the Skywriter, the Flick also senses touch – in its centre and on the four edges – so it's a versatile input device that could prove useful for countless projects.

Interestingly, it even works with the Skywriter Python library, from which the Flick library is derived. We were therefore able to use the Skywriter software examples, including a fun theremin synth.

One advantage of the Flick HAT is the availability of optional cases for all three models. The cases use a non-conductive surface, which does not interfere with the Flick's ability to track gestures.

Related

SKYWRITER HAT

Based on the same chip as the Flick, Pimoroni's 3D gesture-tracking board boasts similar performance. There's also an XL breakout version.

£16 / $21

magpi.cc/10APeHb

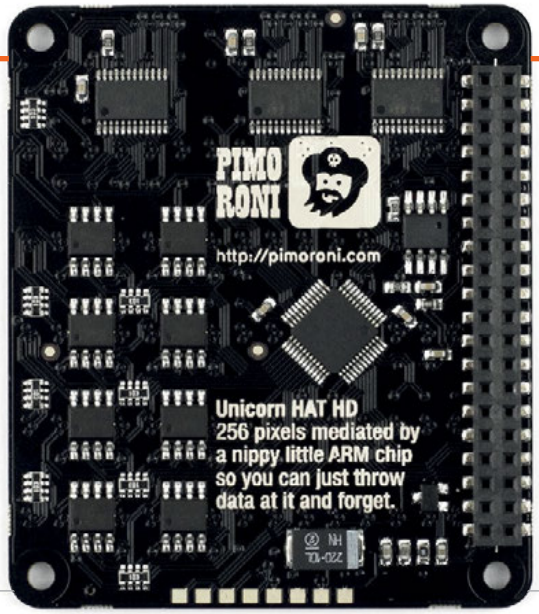
Last word

The performance of the Flick HAT is very similar to that of the Skywriter HAT, but the Flick offers an optional snug-fitting case, as do the other Flick models. Communicating with the Pi via I²C, the Flick only uses a small number of GPIO pins. With the ability to detect a wide range of gestures and touches, it would be a useful input device for many projects.

★★★★☆

magpi.cc/2ultfMn

£32/$41



Maker Says

"256 RGB LEDs in a 16×16 matrix... High-definition rainbow goodness!

Pimoroni

UNICORN HAT HD

Create brighter projects with the new Unicorn HAT HD

The Pimoroni pirates have upped their game with this new HD version of the classic Unicorn HAT, featuring a 16×16 array of super-bright LEDs. Boasting four times the number of RGB pixels of the original display, it can do a lot more and has a real wow factor.

The board comes pre-assembled with its female GPIO header, so there's no soldering required. All you need to do is attach the diffuser layer to the top of the LED array using the supplied nuts and bolts. The diffuser makes a big difference to the visual effect, filling out the gaps in the display between the rather small pixels.

Communicating with the Raspberry Pi via SPI, the HAT uses only four GPIO pins (plus power and ground). Best of all, it has its own ARM STM32F chip to do all the heavy lifting, acting as a middleman between the Pi and the three LED drivers. This means there's no lag at all when you send data to it, as demonstrated by the camera program downloaded with the one-line software installer.

The camera demo displays the low-res live view from the Camera Module (although it was tricky to connect the latter to the CSI port on a non-Zero Pi model with the HAT sitting on top).

Other example programmes also showcase the Unicorn HAT HD well, particularly the snazzy shading demo which transitions between four classic graphics effects to produce some awesome eye candy. A Snake game and Conway's Game of Life demo really benefit from the increased number of pixels, confirming how much more versatile this display is compared with an 8×8 version.

There's even a version of Unicorn Paint that you interact with via a remote web browser, your painted pixels appearing almost instantly on the HAT.

The Unicorn HAT HD has its own Python library, including functions to set the brightness and rotation. Scrolling text across the display isn't as easy as using a single function, requiring a fairly complex loop, but you could adapt either of the impressive multicoloured text demos for this purpose.

Related

ADAFRUIT RGB MATRIX HAT + RTC

This HAT makes it easy to control HUB75-type LED matrices (which you'll need to purchase separately) using a Raspberry Pi.

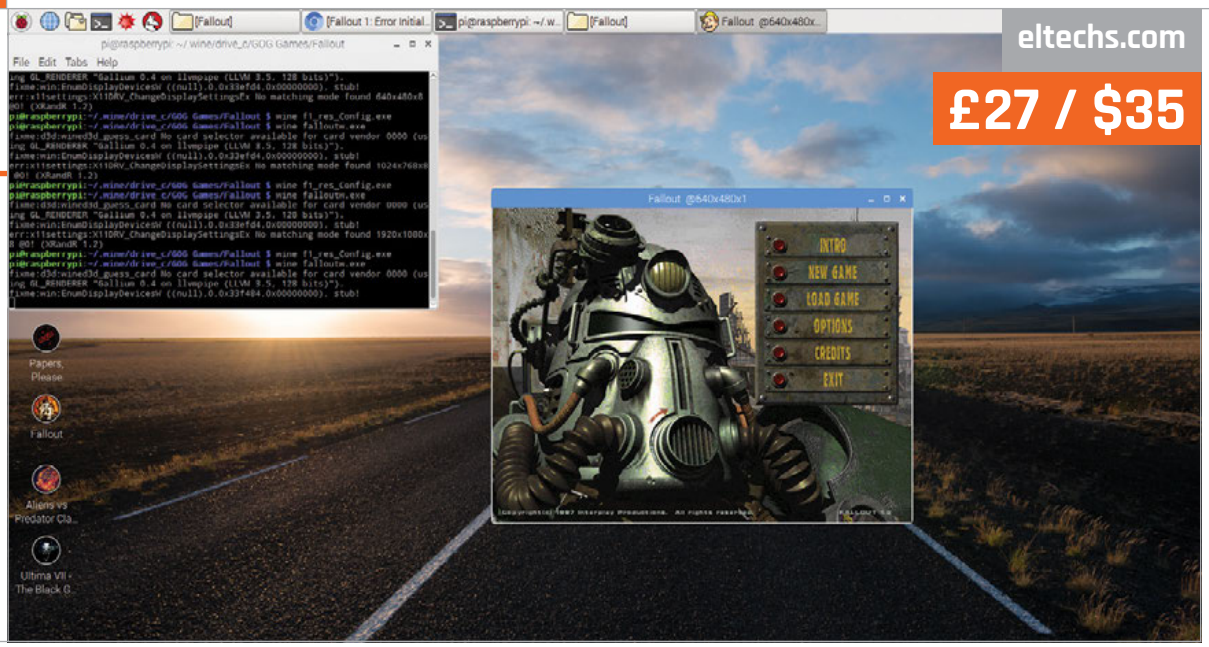
£26 / $25

magpi.cc/2u9xlju

Last word

The increased number of pixels means the Unicorn HAT HD is a more versatile display than its predecessor. The performance is excellent, too, as it reacts near instantaneously to whatever data you throw at it. Since the HAT's ARM chip does all the processing, it's even technically possible to drive multiple displays from one Pi.

★★★★★



eltechs.com

£27 / $35

Maker Says

"Run Intel x86 applications on ARM-based mini PCs"

Eltechs

ELTECHS EXAGEAR DESKTOP FOR RASPBERRY PI 3

Run x86 programs for Linux and Windows using this virtual machine

Eltechs' ExaGear Desktop is a virtual machine that allows you to run applications designed for standard x86 processor architectures on the Pi's ARM CPU. It's limited to 32-bit (x86/i386) software, and running a VM can't magically increase the Pi's limited processor power, but we were pleasantly surprised by its capabilities.

We used ExaGear's default Debian 8 guest OS (it can also host Ubuntu 14 and 16). This provides instant access to a wide range of x86 software via Debian's standard repositories. We were able to quickly and easily install popular programs including Spotify, Dropbox and Steam, as well as compiling software from source.

Spotify was slow to load, but worked perfectly once it started up, turning our Pi into a capable streaming jukebox. The Steam client will run, but that doesn't mean you'll be able to use most of its games and features. We installed a few games from our collection, including Osmose and World of Goo, but performance on both was sluggish and unsatisfactory. We had better luck with classic games from GOG.com, such as GOG's pre-packaged Linux x86 versions of Eye of the Beholder and Loom.

Using Wine, we were able to install a surprisingly wide range of Windows software, although we were once again limited to 32-bit programs. Turn-based RPGs and strategy games are good choices here, as the gameplay isn't particularly sensitive to lag.

Eltechs provides online guides to setting up games including Arcanum and Fallout. Fallout worked well, but slowly, after we tweaked its graphics settings. We were pleased to find that much-loved text editor Notepad++ also worked beautifully, as did Microsoft Office 2003.

ExaGear is particularly handy for old-school gaming enthusiasts, as the Pi's limited processor power, graphics capabilities, and memory are best suited to titles from the mid-90s to mid-2000s. While many tools for playing older games have native Pi implementations, ExaGear makes it easier to use modern, legally available installers from digital retailers like GOG and Steam, while Wine provides support for early Windows titles.

Helpfully, if you want to be sure that ExaGear can run a specific piece of software, there's a free three-day trial available, so you can try before you buy.

Last word

ExaGear is worth its lifetime price if you need a specific piece of x86 software, or simply want the widest possible range of applications available to tinker with.

★★★★☆

Related

QEMU

QEMU is a free and open-source virtual machine hypervisor that allows you to virtualise a wide range of operating systems, but you'll have to create or find your own images.

Free

qemu.org

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Also inside:
UNICORN HAT HD, FLICK & EXAGEAR REVIEWED
GET STARTED WITH SCRATCH 2.0 & THONNY
USE THE SENSE HAT WITH MATPLOTLIB
BUILD A RASPBERRY PI PHOTO BOOTH
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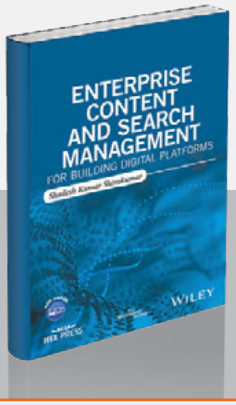
RASPBERRY PI BESTSELLERS

KNOWLEDGE MANAGEMENT

From academia to enterprise; knowledge sharing, storage, and searching present great challenges.

ENTERPRISE CONTENT AND SEARCH MANAGEMENT

Author: Shailesh Kumar Shivakumar
Publisher: Wiley
Price: £68.50
ISBN: 978-1119206811
magpi.cc/2tmAWWO



Information management for enterprises with a business case in mind – if they're ready to take on Shivakumar's extensive prescription for CMS developers, data architects, management, and content strategists.

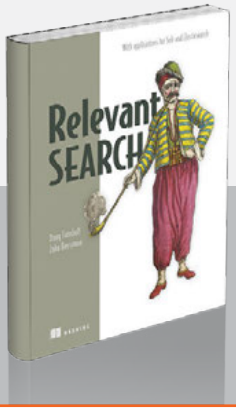
NEW CHALLENGES FOR KNOWLEDGE

Author: Renaud Fabre
Publisher: Wiley
Price: £92.50
ISBN: 978-1786300904
magpi.cc/2taGOqT

Sharing economy models are rippling through the world of scientific knowledge and research; open access brings challenges for developers, researchers, and policy makers – all treated here in the context of law-making.

RELEVANT SEARCH

Authors: Doug Turnbull, John Berryman
Publisher: Manning
Price: £27.99
ISBN: 978-1617292774
magpi.cc/2uZx67Z



The key to successful search delivery is relevance, and Turnbull and Berryman have the expertise to deliver the results your users want. Includes Solr, Elasticsearch, and a useful Python example.

CODING FOR BEGINNERS: USING PYTHON

Author: Louie Stowell
Publisher: Usborne
Price: £12.99
ISBN: 978-1409599340
magpi.cc/2tn6try

Those who fondly remember the Usborne coding books of the 1980s will be pleased to learn that the publisher has released several of them as free PDFs, to "celebrate the release of Coding for Beginners: Using Python." The Python coding intro itself, reviewed here, follows the Usborne tradition, with plenty of busy graphics and cartoon characters that seem to keep young learners interested while they learn new concepts.

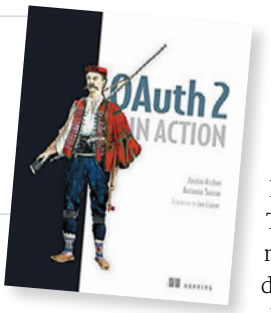
The basics are introduced in a logical order. Then, after conditionals, come flowcharts – and planning programs – which is great to see in a book for young learners. Before it gets too serious, there's an example text adventure to type in: Castle Dragonsnax. The game is gradually expanded to introduce new concepts like importing modules, and using loops. More games and loops follow; followed by lists and dictionaries; then a spot of DIY encryption.

Graphics are introduced with the turtle module, used to draw a snowflake. Graphical games sidestep the usual Pygame route in favour of Tkinter, and its canvas model. The example minefield and Pong-type games give learners many of the techniques needed for building all sorts of other games. There's a lot of learning crammed into a small and easy-to-read book: recommended.

Score ★★★★☆

OAUTH 2 IN ACTION

Authors: Justin Richer, Antonio Sanso
Publisher: Manning
Price: £27.99
ISBN: 978-1617293276
magpi.cc/2uqzWFZ



We've all signed into a website with authentication from another common site. This authorisation via a delegation protocol makes the web both easier to navigate, and more secure. At the heart of nearly all these logins is OAuth 2.0. The protocol behind it, and its extensions, has a great deal of power and flexibility.

The sample code in the book is a Node.js application, using Express.js, and worked through to emphasise the OAuth 2.0 learning, without worrying about the JS. The book is split into sections, and after the first two explanatory chapters, these can be tackled in any order as needed.

OAuth 2.0 is capable of many uses, and many anti-patterns that the authors work hard to warn against. The warnings will help make your site secure by default. The advanced chapters on tokens and dynamic client registration are likely to be very useful for some Pi-based IoT projects. Readers may also be interested in the section on User Managed Access (UMA), which allows users to delegate access to each other – useful in many federated networks and P2P situations.

Score ★★★★☆

LEARNING BLENDER

Author: Oliver Villar
Publisher: Addison Wesley
Price: £24.99
ISBN: 978-0134663463
magpi.cc/2tQIMet

Free software advocates need make no apologies for Blender's interface and capabilities – but it does differ from other 3D rendering software, and if you're new to it you'll also benefit from a guide. There is no better helper than Oliver Villar, who has spent a decade using the tool professionally, and teaching others; and is behind the helpful **blendtuts.com** site.

By focusing on character creation, Villar is able to cover several key aspects of 3D work – from pre-production, through modelling, to shading and animation. Villar is aiming to help professionals understand the workflow away from their specialist area, as well as providing the enthusiast with all the knowledge they need to create something really great.

Packed with insider knowledge, this is a practical book. It features walkthroughs of tasks, and the specifics of Blender's tools (such as marking seams on the UVs), as well as discussing wider considerations (such as when your mesh doesn't need a UV), and working with meshes and modifiers. Tip boxes keep you on track, and cautions contain useful professional hints. Exercises at the end of each chapter involve thinking about what you're learning, and enhancing your practical knowledge.

Score ★★★★☆

FUNCTIONAL PROGRAMMING IN JAVA

Author: Pierre-Yves Saumont
Publisher: Manning
Price: £27.99
ISBN: 978-1617292736
magpi.cc/2vkNj6R

The emphasis here is on functional programming (FP), rather than on Java. Although Java is used throughout, it's not to show off any recent Java 'functional' features – rather Saumont demonstrates functional thinking. He uses a technique of explaining functional concepts, and then using several well-chosen exercises to help the ideas click for the reader.

The author is aware that for a simple programming paradigm, FP is very hard to grasp for those steeped in imperative programming, mutable data, and changing state. Early chapters start with simple functions, and refactoring typical Java code. The style is a very pure FP, which wouldn't be out of place in a Haskell tutorial – but it is grounded in practical code, such as email validation, building on typical Java methods.

Recursion moves from stack-based to heap-based functions to prevent stack overflow, then data takes its rightful place at the centre of the rest of the content: from linked lists, and advanced list handling, to practical problem solving with trees. Coverage of state mutation, I/O, and sharing mutable state shows a commendable willingness to engage the real world that is sadly not found in all FP tutorials. Challenging, thoughtful, and practical.

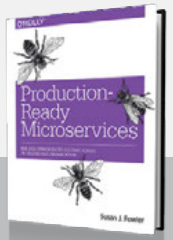
Score ★★★★☆

ESSENTIAL READING: IT TRENDS

Whether managing IT teams, or steering your career, there are always new subjects to read up on.

Production-Ready Microservices

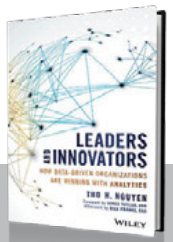
Author: Susan Fowler
Publisher: O'Reilly
Price: £31.99
ISBN: 978-1491965979
magpi.cc/2tmHBQO



Very useful overview of splitting up a monolithic API; written for engineers, but presented at a management-friendly level of abstraction.

Leaders and Innovators

Author: Tho H Nguyen
Publisher: Wiley
Price: £39.99
ISBN: 978-1119232575
magpi.cc/2taV6Yu



Data management and analytics to beat your competitors; full of examples and case studies of big data wins.

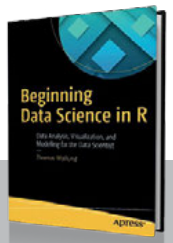
Getting Goosebumps

Authors: Bryan Adams, Dave Hazlehurst
Publisher: Wordscapes
Price: £12.00
ISBN: 978-0993022159
magpi.cc/2umDOqK

If digital marketing is a mystery to you, this will help you work out what to say to your audience, and how to delight them.

Beginning Data Science in R

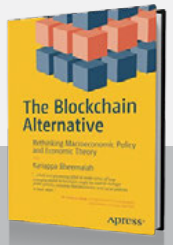
Author: Thomas Mailund
Publisher: Apress
Price: £27.99
ISBN: 978-1484226704
magpi.cc/2tn7vUx



A book of two halves: first get to grips with the ideas of data science, then use R to learn more deeply.

The Blockchain Alternative

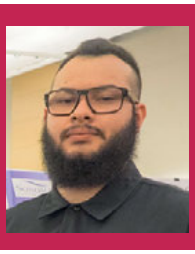
Author: Kariappa Bheemaiah
Publisher: Apress
Price: £14.99
ISBN: 978-1484226735
magpi.cc/2uhzkC4



As blockchain tech revolutionises currency, supply chains, and even medical record-keeping, Bheemaiah reassesses the entire financial system.

BENCHMARKING A RASPBERRY PI CLUSTER

How a recent computer science convert used the Raspberry Pi in parallel for his degree



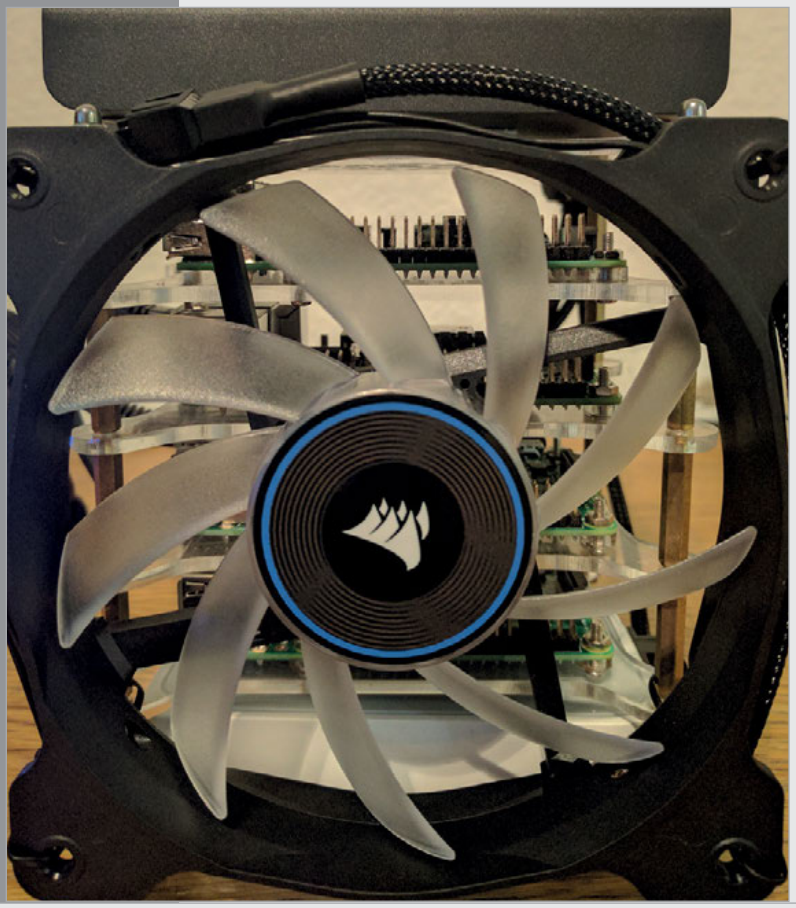
Rigoberto Moreno Delgado
Although relatively new to computer science, Rigoberto has recently graduated from Sonoma State University with a bachelor's degree in the subject.

Rigoberto Moreno Delgado was, like many other college students, unsure which path to go down. After taking a class on computer science, he decided to pursue it as his major, and became interested in parallel computing.

"I began my journey into parallel and high-performance computing after my university advisor, Dr Ali Kooshesh, mentioned that my favourite professor, Dr Suzanne Rivoire, was teaching a course titled Parallel Computing," Rigoberto explains to us. "I was sceptical about enrolling into the class since I had no idea what parallel computing was, but I decided to take the course and I did not regret my decision."

He met Dr Barry Rountree, a researcher at a lab that specialises in supercomputing, while working as an intern at the Lawrence Livermore National Laboratory (LLNL) over the summer of 2016.

"I was inspired to build my own cluster so that I could gain more experience with a distributed system," Rigoberto tells us. "I also needed a plan for my senior research project."



Below The cluster itself is quite compact – a benefit of using four credit-card-sized computers

A cluster of Pis

Rigoberto was able to submit this idea as his senior research project, and began researching. "The biggest challenge was to find a suitable, inexpensive computer that I could use as the nodes for my cluster. I originally thought about purchasing old desktops and chaining them up together to form a Beowulf cluster, but I wanted my cluster to be portable. The best choice was to use Raspberry Pis."

The cluster consists of a modest four Raspberry Pi 3s networked together. There's also a cooling fan connected to the makeshift chassis for the setup, and extra heatsinks on the CPUs to help keep the system well ventilated.

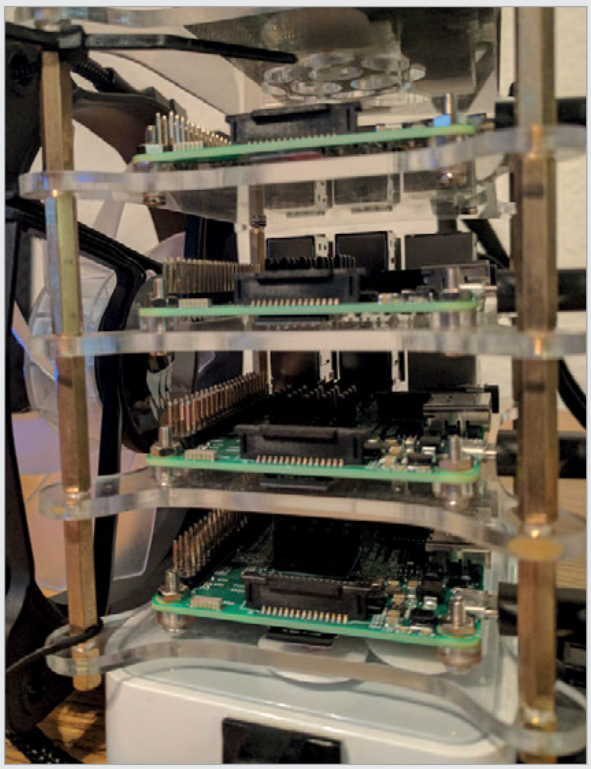
"My initial thought was that the CPU on board the Raspberry Pi would be the biggest limiting factor to obtaining the best performance out of the cluster," Rigoberto says of his experiment, "but I had high hopes for my cluster."

Benchmarking a cluster

Rigoberto performed two major tests on his cluster, a Matrix Multiplication and an HPL (High-Performance LINPACK) benchmark.

The Matrix Multiplication benchmark involves taking two matrices of the same size and multiplying them. The benchmark works by creating two matrices of random numbers of a given size.

Below All the Raspberry Pis are powered by the same USB hub, and connected over the network so they can communicate with each other



MPI (Message Passing Interface) is used to distribute evenly sized chunks of the matrices via Ethernet to every node/process, so that they work their chunk in parallel. Then the results are gathered for each node/process.

This benchmark benefits heavily from parallel execution, since the matrices can be broken down into smaller chunks which can then be sent via Ethernet to other nodes to be worked on in unison.

> "The best choice was to use Raspberry Pis"

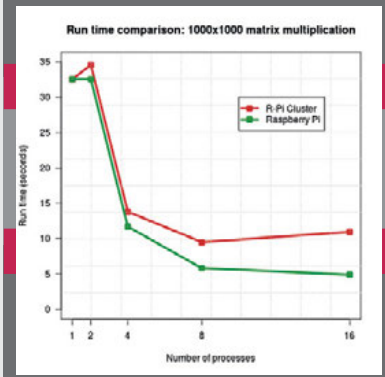
The HPL benchmark is used by the Top 500 List (**top500.org**), which is comprised of the top 500 performing computer systems in the world. The rankings are determined by how many FLOPS (floating point operations per second) a computer can calculate.

Rigoberto was successful in earning his Computer Science degree, with this cluster as his senior project, but he's not quite done with running benchmarks on it:

"Future work involves changing the current operating system (Raspbian Jessie Lite) to CentOS 7 and measuring performance differences, as well as optimising the kernel to better suit the cluster. I would also like to find a method to put Gigabit Ethernet on each Raspberry Pi in my cluster to measure the performance gains that a faster interconnect would present."

BENCHMARK RESULTS

Matrix Multiplication tests



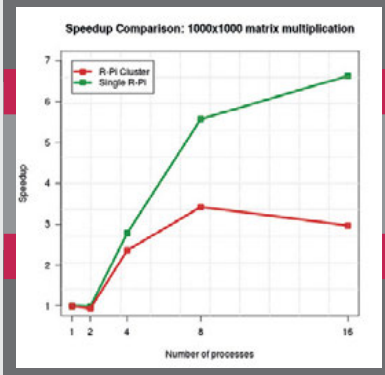
RUN-TIME COMPARISON

TEST:

A simple comparison of how fast the cluster runs, versus the speed of a single Raspberry Pi

RESULT:

The Raspberry Pi cluster was slightly slower than the single Raspberry Pi



SPEEDUP COMPARISON

TEST:

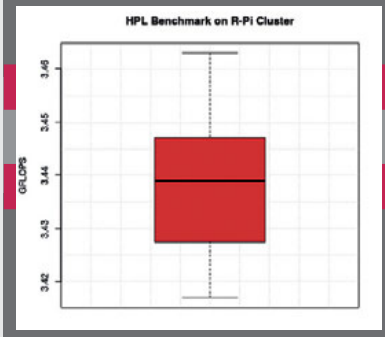
A comparison of how different numbers of processes running in parallel perform

RESULT:

The cluster is significantly worse than the Raspberry Pi on its own

RIGOBERTO SAYS:

"The combined resources that the cluster has make it more powerful than a single Raspberry Pi, but that does not make it faster with regard to the small-scale matrix multiplication that I used. The main reason why the cluster is not able to outperform a single Raspberry Pi is the interconnects between the nodes. Using the on-board Ethernet (10/100 Mbps) limits how quickly nodes/processes can communicate with each other."



HPL TEST

TEST:

A pure test of computing power

RESULT:

3.463 GFlops

RIGOBERTO SAYS:

"My cluster was able to achieve a peak of 3.463 GFlops. Of course, that is nowhere close to being up to par with the systems in the Top 500 list [which can be more than a million times faster]. As you can see from the graph, most of the scores sit around 3.43 and 3.45 GFlops. The HPL benchmark greatly benefits from having fast interconnects (Ethernet in this case). Had the Raspberry Pis had faster Ethernet speeds (preferably Gigabit), the GFlops that could be obtained by the cluster would be a lot higher than they currently are."

THE MONTH IN RASPBERRY PI

Everything else that happened this month in the world of Raspberry Pi

WIN! 10 RASPBERRY PI 3 & CASES SIGNED BY EBEN
The MagPi
THE RASPBERRY PI PC CHALLENGE
What can't you do with a $35 computer?
CREATE A SATNAV ROBOT
DESIGN A DOG TREAT DISPENSER
BUILD A GPIO TRACKING DEVICE
MASTER BLUETOOTH
12 SUMMER PROJECTS

THE RASPBERRY PI PC CHALLENGE

Here are some of the stories we've heard from you about your experiences of using the Pi as a PC

In the last issue, we ran the Raspberry Pi PC challenge. Our Features Editor, Rob Zwetsloot, used a Raspberry Pi as his main PC for a week. A few readers were interested to see the results to ascertain whether or not they could give it a try, and a few gave us their experiences of doing the same thing.

Replacing a Mac with a Pi

Rob's experiment, while thorough, was conducted from the perspective of a Windows and Linux user. Trust us: you don't want to hear him talk about Macs! For people who do use Apple computers, a similar guide explaining how one Pi user replaced their Mac for a week with a Raspberry Pi is available online. Pierre-Gilles Leymarie had the misfortune of losing his MacBook in Paris, and had to come up with an alternative. He did a great job of setting up his Pi as a replacement, though, and you can read all about it here: **magpi.cc/2vnULhR.**

Nicholas Tate

I use several Raspberry Pi 3s as my main computers. For getting many of the day-to-day tasks done, they have proven to be superior to Mac or Windows machines. I have all kinds of apps that work flawlessly, and would cost serious money on PCs and Macs. The OS runs on a 500GB SSD, which ensures that it boots and loads programs quickly.

Annie C

My parents are using a Raspberry Pi 3 as their only computer to browse the internet and to play some simple games like Tetris and card games. As they are usually not doing multiple things at the same time, they don't run into performance issues. I tested their Raspberry Pi while I was setting it up, and it was way better than I expected.

What I couldn't solve is calls in Google Hangouts or Skype. Regardless of the USB audio device I use with the Raspberry Pi, the sound only works for a few seconds, then it shuts down. When playing videos in Chromium, it works without problems.

Chuck Dombek

I've used the Raspberry Pi to offload background tasks like BOINC from my main system, as well as to support my ventures into learning Python, and it more than meets the challenge. I've even been known to work on documents using LibreOffice if my main system is tied up. For its cost, it does the job quite nicely.

JAMS IN PICTURES

Here are some pictures from Pi events around the world over the last month

Egham Jam

twitter.com/EghamJam

We love the mixture of old and new computing here – hopefully some of the younger attendees will learn a bit of history!

Milton Keynes Raspberry Jam

twitter.com/MKRaspberryJam

Everyone loves a good robot fight! Pi Noon is a popular competition from Pi Wars, and it looks as if these robots are getting some practice in...

ISTE 17

iste.org

ISTE is a big educational conference that concentrates on technology. The Raspberry Pi North America team were there to demonstrate how the Pi can be used in computing education.

Raspberry Pi
@Raspberry_Pi
Following
The #ISTE17 Raspberry Jam is happening now in Towerview Lobby. Free copies of our educator magazine Hello World while supplies last. #rjam

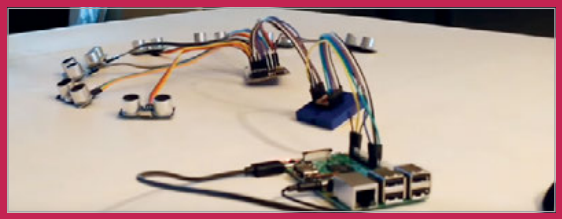
RASPBERRY PI BLOG HIGHLIGHTS

Some posts from the Pi blog that caught our eye. Visit the blog at **raspberrypi.org/blog**.

Ultrasonic Pi-ano

magpi.cc/2utXzNX

"At the Raspberry Pi Foundation, we love a good music project. So of course we're excited to welcome Andy Grove's ultrasonic piano to the collection! It is a thing of beauty... and noise. Don't let the name fool you – this build can do so much more than sound like a piano."



NYC train sign: real-time train tracking

magpi.cc/2uuiyjs

"Raspberry Pis, blinking lights, and APIs – what's not to love? It's really not surprising that the NYC Train Sign caught our attention – and it doesn't hurt that its creators' Instagram game is on point."

Bicrophonic Research Institute and the Sonic Bike

magpi.cc/2utY8ax

"The Bicrophonic Sonic Bike, created by British sound artist Kaffe Matthews, utilises a Raspberry Pi and GPS signals to map location data and plays music and sound in response to the places you take it on your cycling adventures."

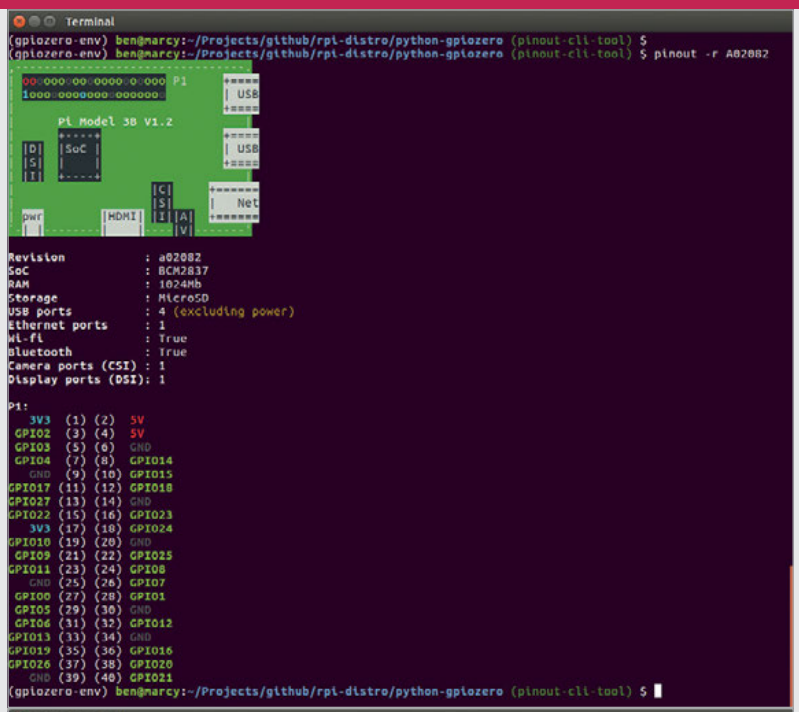
Plane spotting with Pi and Amazon Alexa

magpi.cc/2uukfoE

"Plane spotting, like train spotting, is a hobby enjoyed by many a tech enthusiast. Nick Sypteras has built a voice-controlled plane identifier using a Raspberry Pi and an Amazon Echo Dot."

GPIO ZERO 1.4 AND PINOUT

A new version of GPIO Zero is out and includes a handy diagram for novice coders



A bit late to squeeze itself into the news section for this issue, we thought this was very much worth talking about anyway: a brand new version of GPIO Zero is out! Version 1.4 of the Python library includes a standard selection of improvements and optimisations, but one of the things creator Ben Nuttall, Raspberry Pi Community Manager, is excited about is the new pinout tool on the command line.

"The pinout command-line tool is available to all Raspbian users," Ben tells us. "It shows some information about the Pi you're on, including an ASCII art diagram and a pin layout for your Pi. All Pi models since the B+ (2014) have had the same pinout, but if you have an older model, it'll show you the correct pin layout for that one. It even works on the Compute Module!"

> "The pinout tool is available to all Raspbian users"

There are some pictures on this page to illustrate how it looks – no longer will you need to keep referring back to a 'Raspberry Pi gpio' search in Google Images. And by you, we mean us.

To get the update, run the following command in the Terminal or on the command line:

```
sudo apt update && sudo apt install python3-gpiozero
```

To run the new tool, you simply need to run the command **pinout -h**.

Above left The tool tells you which pin relates to which GPIO number in the code, as well as giving you other information about your Pi

Left The ASCII art for the Pi shows the model you're using, and even works with the smaller Pi Zero

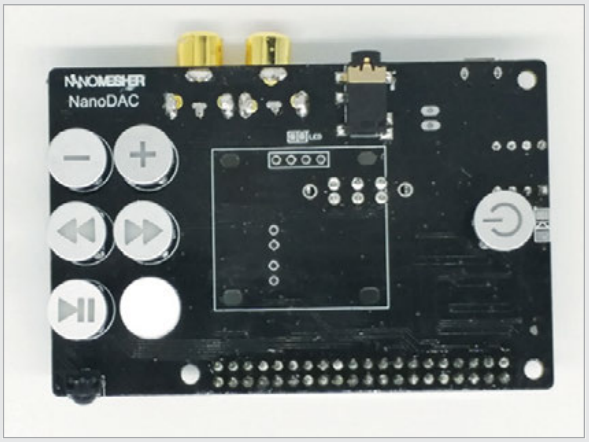
CROWDFUND THIS!

The best crowdfunding hits this month for you to check out...

RASPBERRY SHAKE 4D

kck.st/2ucqplo

You've probably seen the tutorial for the original Raspberry Shake on page 52, and maybe you remember our interview with the creators in issue 57. If you were excited by all that, then you might be happy to know that the latest version of the earthquake-detecting device, Raspberry Shake 4D, is currently in the crowdfunding phase. It hit its goal in just over 30 minutes and is still going strong, so this is a great time to hop on it.



NANOSOUND

magpi.cc/2vu88Nr

We see a lot of Raspberry Pi DACs in crowdfunding. A lot of them are pretty good, and there's clearly a market for them. This one works with Kodi out of the box, includes an IR receiver, and even has a built-in screen. There's a month left in the campaign, so give it a look!

Q.BO ONE ROBOT

magpi.cc/2v07NT4

There have been a few companion robot projects on sites like Indiegogo, but this is the first we've seen that's powered by a Raspberry Pi. The older Q.bo robots were very popular, so it's nice to see a new iteration. You'll have to be quick with this one as it's nearly finished, but it has hit its funding target. It promises to be open-source and it looks pretty cute too!

BEST OF THE REST

Here are some other great projects we saw this month

magpi.cc/2urtsXf

SPOTIFY RADIO

We love the retro styling of this radio, and that the link will take you to the Instructables tutorial on how to build your own! If you look carefully you can see an original Model B, so it will probably work with a Pi Zero as well.

magpi.cc/2ursk66

RASPBERRY PI BEER BREWER

It's been a while since we saw a beer-brewing project using Raspberry Pi, and we do love the idea! This link takes you to up-to-date instructions on how to build the project, so get making and create a microbrewery of your very own.

LIVERPOOL MAKEFEST 2017

With more hands-on activities than ever, Merseyside's maker showcase is inspiring the next generation of creators and technologists

Liverpool MakeFest's third year shows it to be on a very special trajectory – getting better every year, with no sign of slowing down. The MakeFest showcases the best of the Liverpool and North West maker community, with a few special guests from further afield. Held over four floors and the roof of the city's historic library building, it's an exciting blend of old and new crafts, with plenty of hands-on activities for all the family.

Up on the roof

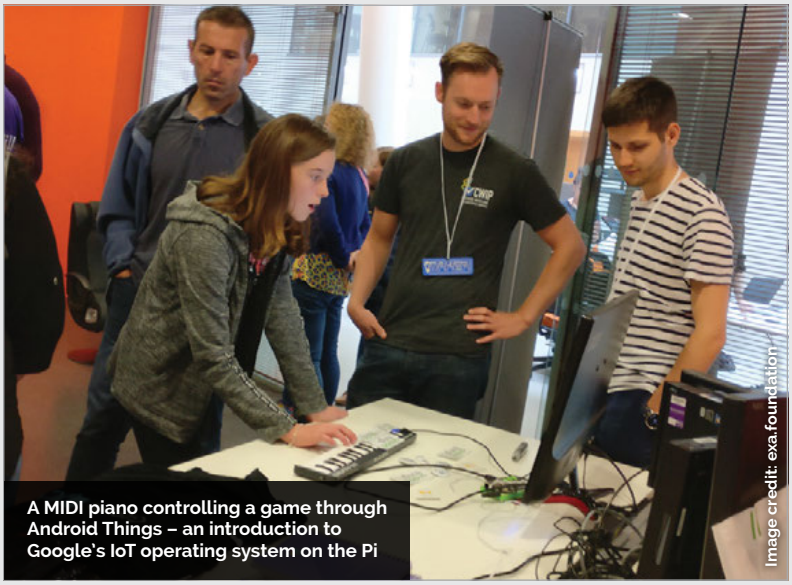
On the roof, two technologies from well before the microcomputer era were being showcased: radio, the original 'wireless'; and telescopes from the local astronomical society. Local arts organisation FACT brought everything up to date by tuning into data from satellites passing overhead.

Outer space continues to inspire many people to learn about technology, and DIY rockets were displayed at the entrance to the library, competing with Liverpool MakeFest's resident Dalek for attention. VR, drones, and games that incorporated IoT devices to bring play into the wider world represented the cutting edge of present-day technology, while artist group Domestic Science took participants back in time with their RFID tag-based MileCastles, part of the Hadrian's Castle exhibition taking place this summer along the length of Hadrian's Wall.

> "exa.foundation brought a full range of Pi-based programming and physical computing"

Crossovers between old and new took various forms. The Liverpool League of Gentlemen and Extraordinary Ladies decorated the library with their presence in full steampunk regalia. Rachel Freire demonstrated her mi.mu gloves, along with a range of sensors and feedback mechanisms incorporated into clothing. The gloves, designed in collaboration with singer-songwriter Imogen Heap, are gestural interfaces for composing and playing music. Thermochromic fabric was demonstrated to young makers by Laura Pullig, an e-textile specialist who was also showing and selling plant-based electronics kits. An electronic/fabric crossover was also found in light-up wind socks; and an automatic knitting machine that controls lighting, sound, and projection by using binary values on a punch card to create RGB colour values. Something is also knitted as a by-product of the process: a novel form of documentation.

Traditional crafts were also represented, including woodworking and guitar making; and plenty



A MIDI piano controlling a game through Android Things – an introduction to Google's IoT operating system on the Pi

Image credit: exa.foundation

Plenty of Raspberry Pis were running young people's first computer programs at the Exa stand

Image credit: exa.foundation

Liverpool Girl Geeks featured graduates from their first ever Girl Geek Academy, inspring more young women to help them close the gender gap in technology

Image credit: JR Peterson

Holding the event on Armed Forces Day resulted in some very smartly turned out visitors at the MakeFest

Image credit: JR Peterson

Traditional crafts are given equal first-class status at maker events

Image credit: exa.foundation

A young Raspberry Pi fan is introduced to Pete Lomas, the Pi's creator

Image credit: exa.foundation

of messy gluing, painting and modelling for younger visitors. Many of the hands-on activities were provided by educational institutions, including Edge Hill University, and local educational projects such as Bootle's Little Sandbox tech club for 8- to 12-year-olds. Pi-based learning was available in the form of Android Things, Scratch, Python and EduBlocks (see issue 53 of The MagPi), as well as tiny Pi-powered robots fighting to pop each other's balloons in the Micro Pi Noon activity.

The exa.foundation brought a full range of Pi-based programming and physical computing to the event. Exa's Alan O'Donohoe (of Raspberry Jam fame) had an interesting tale to tell: "A young child fan of the Raspberry Pi was telling me how great he thought it was, just as I spotted Peter Lomas [designer of the Pi]. When I introduced Pete to the young lad, he asked me to photograph them together. It made his day – probably his whole weekend. The lad could barely speak, he was that thrilled."

Tech with a purpose

If 3D printing has begun to seem old hat to you, consider two of the exhibitors. MeLT-3D were making pasta cutter dies with their printer, along with moulds for everything from silicone, plaster, and metal to chocolate! Dr Laura James of Field Ready showed some of the 3D-printed pipe fittings and medical supplies that are saving lives at disaster scenes across the planet. Field Ready relies on a worldwide network of engineers and makers to support them with practical modelling work and engineering know-how.

For the full, and inspiring, list of exhibitors, visit **magpi.cc/2uddHmO**.

This year's event saw the organisational duties taken up by Jen Fenner and Mark Sabino, working with Central Library's Denise Jones. We asked Mark what stuck in his memory about this year's event. "My personal highlight has to be the women in tech showcase, which saw Rachel Freire's first show in her home town after 14 years' absence to specialise in controversial fashion, now collaborating with technologists on a variety of wearables including whole-body-interaction instruments," he told us. "Also, having Field Ready and the Humanitarian Makers demonstrating what they do in crisis situations with 3D-printed solutions, along with FACT tracking the ISS, and Quantum Tech Club exposing the sun via radio."

Mark was also enthusiastic about having "yet another year to plan, to include the spectaculars we never managed for MakeFest 2017 – which includes starting a crowdfunding exercise to buy John Cartwright's Dalek, as he's retiring as the owner/operator."

We look forward to Liverpool MakeFest 2018. If you can't wait, there is a MakeFest at Manchester's Museum of Science and Industry, 19-20 August, amid the vivid exhibits of industrial milestones in manufacturing, flight, and computing. If you can't find an event near you, get down to your local makerspace and see what's planned – or get involved yourself. There's a generation waiting to be inspired by your engineering and maker skills.

COMMUNITY PROFILE

RICHARD HAYLER

One of the newest members of the Raspberry Pi Foundation team is no stranger to the community

Richard

Category: Maker

Day job: Raspberry Pi Foundation's Citizen Science Programme Manager

Website: magpi.cc/1lLmeoi
twitter.com/rdhayler

"I wish Richard was my dad!" We've heard this more than once from various members of the Raspberry Pi community. And with Richard's active blog and Twitter account continuously sharing exciting Pi-related adventures with his sons, Jasper and Ozzy, you can see why. From pool noodle lightsabers to high-altitude ballooning and International Space Station photography, the experimentation of Richard, his family, and those he mentors in Code Club and CoderDojo always brings a smile to our faces.

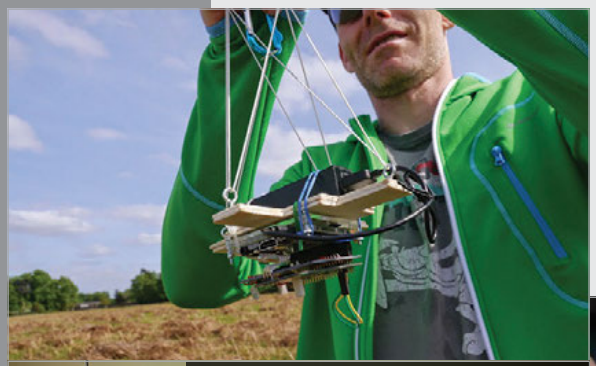
More recently, Richard joined the ranks of official Pi Towers employees, becoming the Foundation's new Citizen Science Programme Manager. The job involves running the Oracle Weather Station project, while thinking up other interesting future endeavours.

An unexpected journey

Richard began his career as a physicist, before moving on to work in various computing and engineering roles with the Foreign Office. So it's no wonder that he was already tinkering with the likes of the Arduino when the Raspberry Pi came to town. As the father of two children, Richard was keen to increase their hands-on experience with code and tech, so he decided to start a Code Club at their school.

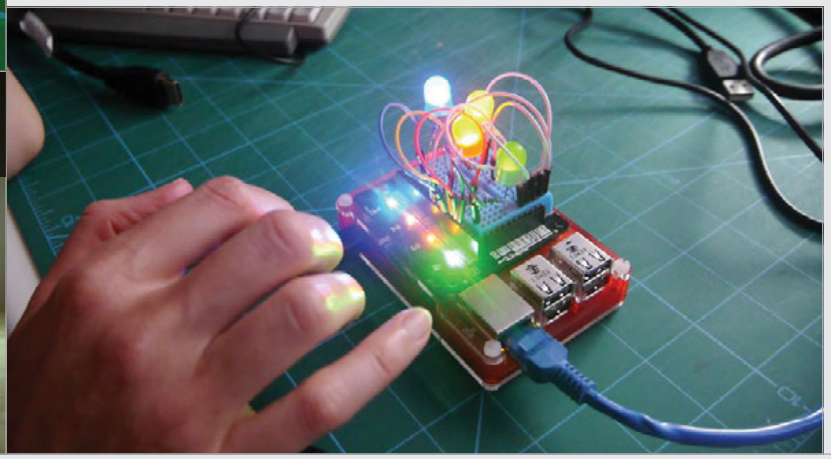
"It's all Clare's fault, really," Richard jokes when discussing how he fell into the land of Raspberry Pi, referring to Code Club co-founder

Below As an all-round maker and club runner, Richard builds interesting projects with his sons Jasper and Ozzy



Together with Jasper and Ozzy, Richard created *The Evolution of Raspberry Pi*, a LEGO-based journey from factory to maker, and on to the International Space Station

Below Richard's blog features detailed posts covering his experimentation with tech, continued work with clubs and Jams, and shared code for his fun builds



HIGHLIGHTS

coderdojoham.org

CODE CLUB + DOJO + JAM

Richard started a Code Club at his sons' school, and soon found himself deep in the coding community. He expanded his volunteering to CoderDojo and Raspberry Jams, and has even written a few articles for *The MagPi*.

magpi.cc/2u8Gvwt

HIGH-ALTITUDE BALLOONING (HAB)

Richard attended Skycademy, a HAB-themed programme run by the Foundation to help teachers send a Raspberry Pi to near space. His balloon reached 35 km before bursting, luckily landing nowhere near Heathrow airport and the London Control Zone, both of which are potential hazards when trying to launch so close to home.

magpi.cc/2s26F0a

KITE MAPPER

Richard and his sons created a kite mapper using a Raspberry Pi and a newly acquired kite. Utilising the Pi and Camera Module, they were able to collect location and distance data alongside their images.

Clare Sutcliffe. From Code Club, Richard found himself taking part in Cat Lamin's first Coding Evening, where he was introduced to a CoderDojo champion – leading him to mentor at CoderDojo Ham. And if that wasn't enough, he also helps out at the East London and Wimbledon Jams, mentors a Pioneers team, and entered PiBorg's Formula Pi and Cam Jam's Pi Wars events. Richard is one of the poster children of the Raspberry Pi community, and we're pretty sure he never sleeps.

> "Richard's blog posts reveal a plethora of fun and interesting maker builds"

Reaching for the stars

A browse of Richard's blog posts reveals a plethora of fun and interesting maker builds, each with detailed explanations of the why and how, delivered by a true scientist.

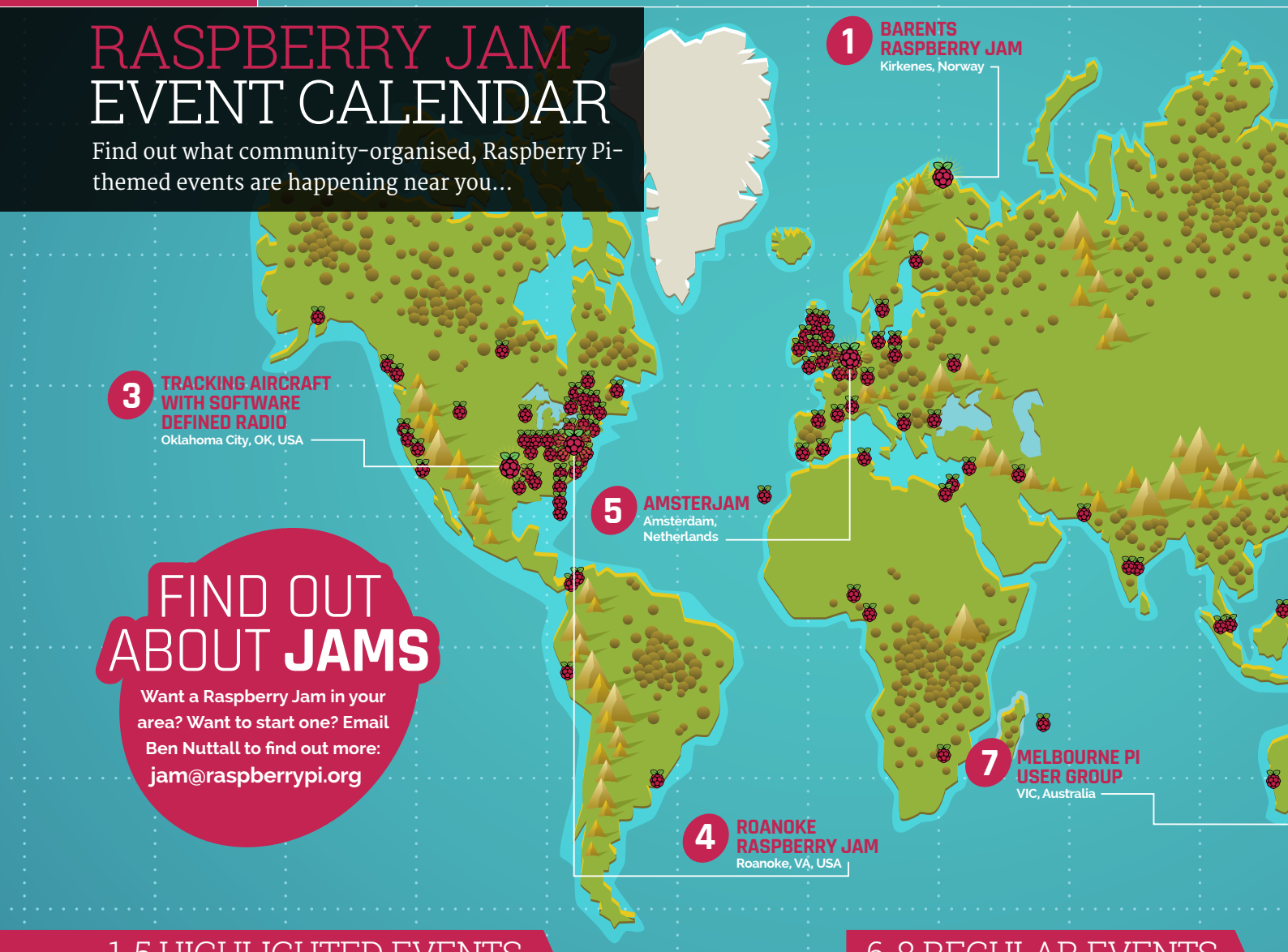
Among his favourite Raspberry Pi–themed projects, Richard was quick to highlight the work he's done with clubs, most notably the primary school team he mentored for the first Astro Pi challenge. "To then be told that your club is one of the two winning entries for the Astro Pi primary school competition is – literally – out of this world," explains Richard in his blog entry of the day.

Cranmere Primary School's Crew Detector (code-name 'Sweaty Astronaut'), used the sensors of the Sense HAT, primarily the humidity sensor, to detect variations in the atmosphere of the ISS and take photographs if it detected the presence of a crew member via these changes. We can only imagine the utter excitement of receiving your images back from space to find Tim Peake floating about in front of a camera your code was controlling.

Of his other projects, Richard highlighted builds he's created with Jasper and Ozzy, both very present in his photography and blog entries. Yes, we're jealous. Yes, we want to be them. And yes, we can't wait to see what Richard produces on his own, and as part of the Raspberry Pi Foundation team.

RASPBERRY JAM EVENT CALENDAR

Find out what community-organised, Raspberry Pi-themed events are happening near you...



FIND OUT ABOUT JAMS

Want a Raspberry Jam in your area? Want to start one? Email Ben Nuttall to find out more: jam@raspberrypi.org

1-5 HIGHLIGHTED EVENTS

1 BARENTS RASPBERRY JAM

When: Saturday 5 August
Where: Pasvikveien 2, Kirkenes, Norway
twitter.com/BarentsRJam
A Raspberry Jam in northern Norway, promising to show attendees the magic of technology.

2 COVENTRY FABLAB RASPBERRY JAM

When: Friday 11 August
Where: Coventry FabLab, Coventry, UK
magpi.cc/2uqoFFx
A show-and-tell event where people bring their amazing Raspberry Pi projects for others to appreciate.

3 TRACKING AIRCRAFT WITH SOFTWARE DEFINED RADIO

When: Saturday 12 August
Where: StarSpace 46, Oklahoma City, OK, USA
magpi.cc/2uqipO6
Something slightly different: this is about how Raspberry Pis are being used to help track aircraft in flight.

4 ROANOKE RASPBERRY JAM

When: Saturday 2 September
Where: Science Museum of Western Virginia, Roanoke, VA, USA
magpi.cc/2uqsfzp
A joint meeting with the Roanoke Robotics & Makers Club of Southwest Virginia, with an intro to programming on the Pi.

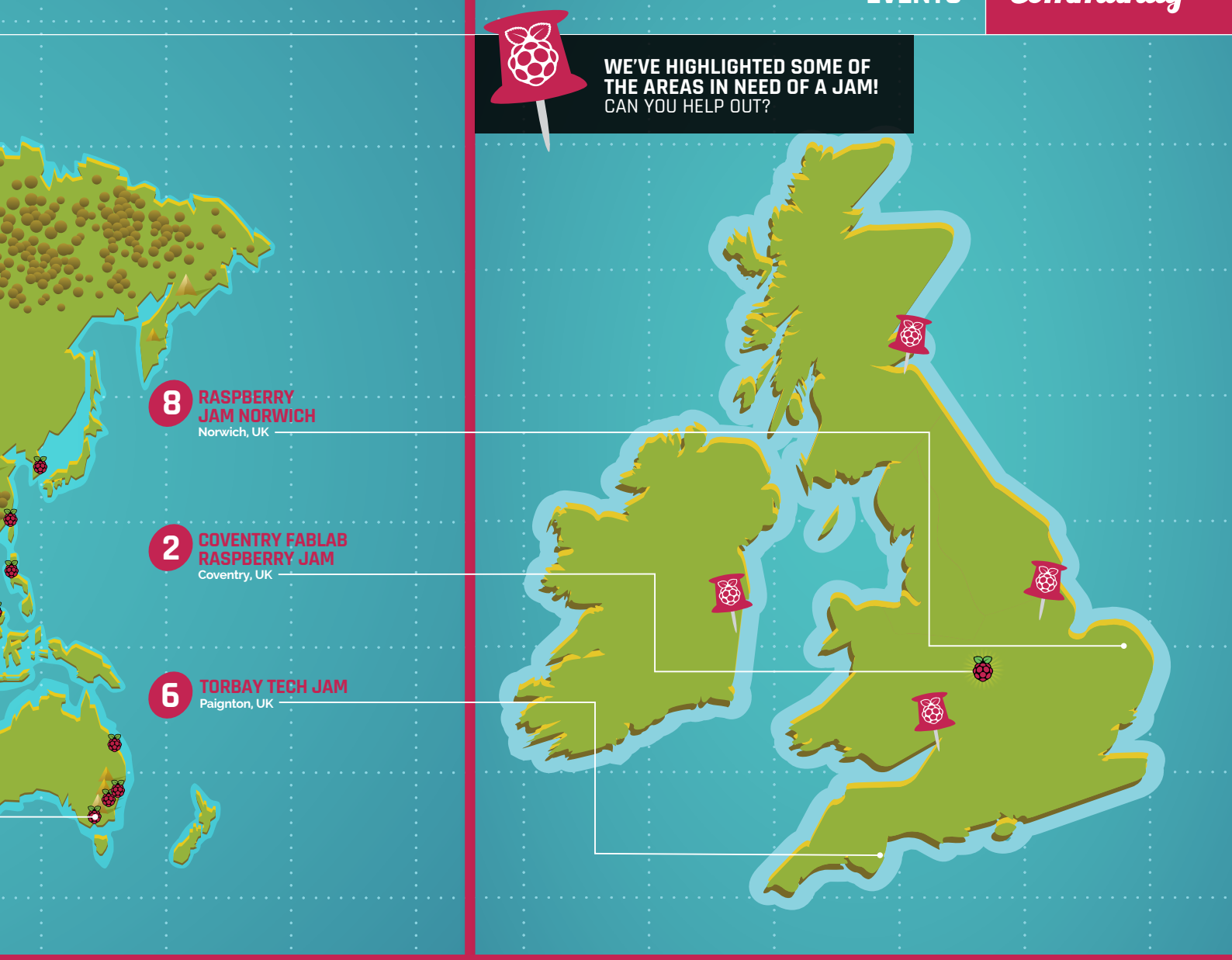
6-8 REGULAR EVENTS

5 AMSTERJAM

When: Saturday 9 September
Where: TQ, Amsterdam, Netherlands
amsterjam.me
A meet-up for Raspberry Pi enthusiasts and people who want to learn more about the capabilities of the Pi in all its forms.

6 TORBAY TECH JAM

When: Saturday 12 August
Where: Paignton Library and Information Centre, Paignton, UK
torbaytechjam.org.uk
A fun, informal and family-friendly event that aims to inspire people, especially children and youngsters, to take an interest in STEM.


WE'VE HIGHLIGHTED SOME OF THE AREAS IN NEED OF A JAM!
CAN YOU HELP OUT?
8 RASPBERRY JAM NORWICH
Norwich, UK
2 COVENTRY FABLAB RASPBERRY JAM
Coventry, UK
6 TORBAY TECH JAM
Paignton, UK

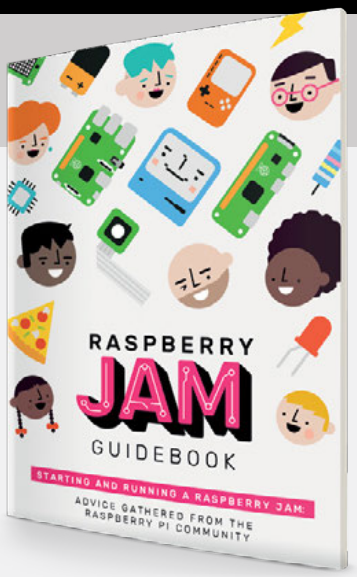
RASPBERRY JAM ADVICE

LOCATION

> "Our local library gave us a venue free of charge: they're just pleased that someone is using the space."
>
> **Cat Lamin**
> Wimbledon Raspberry Jam

Every Raspberry Jam is entitled to apply for a free Jam starter kit, which includes magazines, printed worksheets, stickers, flyers, and more: **magpi.cc/2usaRdw.**

Plus download your free Jam guidebook here: **magpi.cc/2q9DHfQ.**



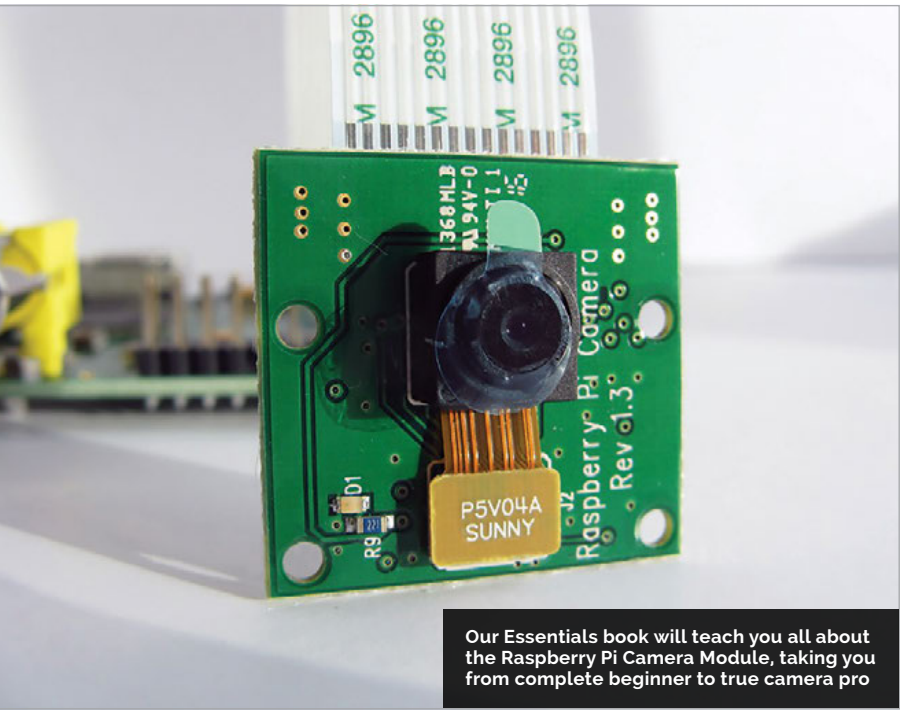
7 MELBOURNE PI USER GROUP

When: Tuesday 15 August
Where: Melbourne Rudolf Steiner School, Warranwood, VIC, Australia
magpi.cc/2mx2y7Y
The group's aim is to bring like-minded people together to talk about how they're using the Raspberry Pi.

8 RASPBERRY JAM NORWICH

When: Sunday 20 August
Where: The Forum, Norwich, UK
twitter.com/NorwichRJam
Bringing the fabulous Raspberry Pi community together at The Forum in the heart of Norwich.

YOUR LETTERS



Our Essentials book will teach you all about the Raspberry Pi Camera Module, taking you from complete beginner to true camera pro

Essential cameras

I love the Essentials range of books that you publish, and am very interested in the new camera one, *The Camera Module Guide*. Did I miss the boat on the print run of this, though? I have all the other Essentials books in print, but can't find a way to purchase this at all.

By the way, is this the start of a new run of Essentials books? What's the next one going to be on?

William

You haven't missed a print run of the new Camera Essentials book – we just haven't done one yet! *The Camera Module Guide* will be available to purchase in the regular A5 pocket-size format later this summer.

As for other Essentials books, you can definitely expect more at some point, but we're afraid we can't discuss when and what they'll be on. Sorry! They're bound to be amazing, although we might be a bit biased on that front.

Digital transfers

I recently took out a digital subscription to The MagPi, as I really enjoy your magazine and wanted to support Raspberry Pi! I bought it on my Android phone, though, before really giving it any thought, and now I'd like to transfer it to my iPad version of the app. Is there any way to achieve this?

Also, if I get a print subscription, do you get a digital subscription with that?

Mel S

Unfortunately, the digital purchases are tied to your account on the individual app stores for both Android and iOS devices, so there's no way to transfer between them, or buy once and use on both. An option for a joint print and digital subscription is something we'd love to provide. However, the systems we use aren't compatible with each other, so it's not something we currently offer.

Do remember, though: if you decide to get the print subscription, you can download PDF versions of every issue of The MagPi completely free from our website.

GETTING THE AIY PROJECTS VOICE KIT

We're still getting emails from a lot of people asking how they can get their hands on issue 57 or the AIY Projects Voice Kit that came with it. We're adding a little boxout here to remind everyone that the kit will be going on sale on its own soon. To find out when the kits will be available, sign up to our mailing list at **magpi.cc/Email-me**. That way, we can let you know as soon as we have a date for the release of the kits.

FROM THE FORUM: FILE STORAGE

The Raspberry Pi Forum is a hotbed of conversations and problem-solving for the community. Join in via **raspberrypi.org/forums**

I have been using my Pi and Camera Module as a security camera. After several days, I received an error that the USB memory stick was full and I had to delete files to make room. Can I code for this? Can I detect that memory is nearly full and have old files deleted automatically so the program doesn't come to an end? Or detect when my USB stick storage is full, then power up an external hard drive, perform a USB stick backup to it, then wipe the USB stick files, and power down the hard drive?
marmaladefly

Forum user **pageauc** came up with a solution: "You could create a simple script to delete files older than a specified number of days. Put this in a crontab to run once a day, or as often as needed. Below is just an example, so edit **find** parameters to suit your needs…"

```
#!/bin/sh
find /home/pi/my_dir -mtime +10 -type f -delete
```

Alternatively, keep the hard drive connected, and copy files to it once a day; or set a NAS drive to turn on at a certain time, then use a **cron** job to copy files to it.

WRITE TO US

Have you got something you'd like to say?
Get in touch via **magpi@raspberrypi.org** or on The MagPi section of the forum at: **raspberrypi.org/forums**

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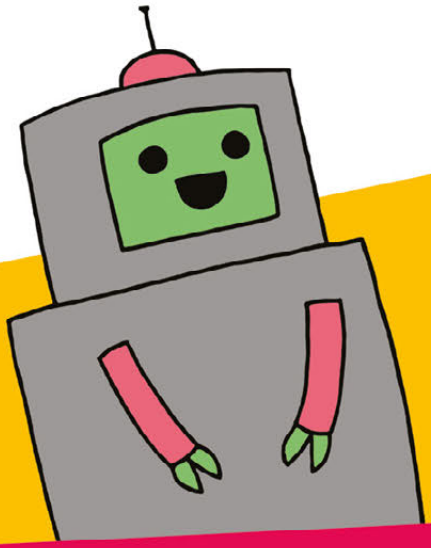
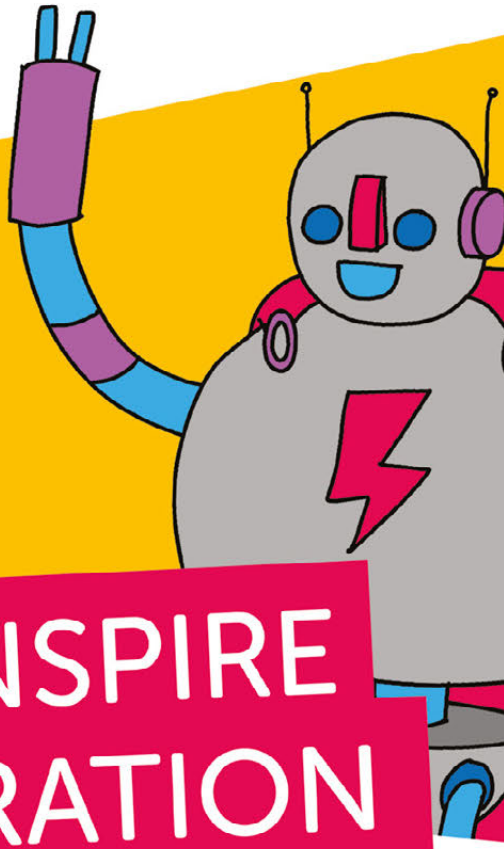


{code club}

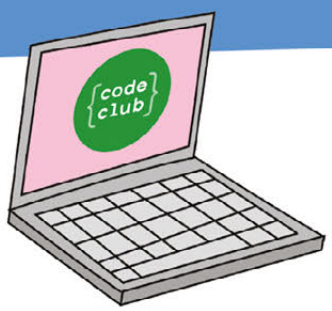


CAN YOU HELP INSPIRE THE NEXT GENERATION OF CODERS?

Code Club is a network of volunteers and educators who run free coding clubs for young people aged 9-13.

We're always looking for people with coding skills to volunteer to run a club at their local school, library, or community centre.

You can team up with friends or colleagues, you will be supported by someone from the venue, and we provide all the materials you'll need to help children get excited about digital making.



To find out more, join us at

www.codeclubworld.org

Code Club is part of the Raspberry Pi Foundation. Registered Charity Number 1129409

WIN! ONE OF TEN

INCREDIBLE RASPBERRY PI PRIZES UP FOR GRABS

PAPIRUS ZERO SCREEN & CASE KITS

We've got ten PaPiRus Zero Medium (2.0-inch) pHAT Screen and Case kits to give away, thanks to Pi Supply (pi-supply.com).

PaPiRus Zero is an ePaper / eInk screen pHAT designed for the Raspberry Pi Zero and Pi Zero W.

The PaPiRus Zero is one of the first true low-power displays for the Pi Zero mini computer, and uses the same ePaper technology found in e-book readers.

Unlike a regular display, ePaper reflects light and is capable of displaying text and images indefinitely, without using electricity. This makes it an incredible tool to add to Raspberry Pi Zero projects.

You can use a PaPiRus Zero to create cool name tags, create an ePaper watch, build a digital sign for a store, or create an outdoor data logging project.

Learn more about PaPiRus Zero on the Pi Supply website (**magpi.cc/2ou5KTh**).

For a chance to win one of these great PaPiRus Zero pHAT Screen and Case kits, you just need to go online and enter our competition. You could be one of the lucky winners!

Enter now at magpi.cc/WinAug17

Terms & Conditions

Competition closes on 31 August 2017. Prize is offered to participants world-wide aged 13 or over, except employees of the Raspberry Pi Foundation, the prize supplier, their families or friends. Winners will be notified by email no more than 30 days after the competition closes. By entering the competition, the winner consents to any publicity generated from the competition, in print and online. Participants agree to receive occasional newsletters from The MagPi magazine. We don't like spam: participants' details will remain strictly confidential and won't be shared with third parties. Prizes are non-negotiable and no cash alternative will be offered. This promotion is in no way sponsored, endorsed or administered by, or associated with, Instagram or Facebook.

MATT RICHARDSON

Matt is Raspberry Pi's US-based product evangelist. Before that, he was co-author of *Getting Started with Raspberry Pi* and a contributing editor at *Make:* magazine.

IT'S A COMPUTER, FULL STOP

How do you introduce people to Raspberry Pi? Here's how **Matt Richardson** does it

A big part of my job involves answering the question, 'what is a Raspberry Pi?' Over time, I've had a lot of practice responding to it. My answer usually starts off short and direct: "Raspberry Pi is a computer, full stop." I'll go on to explain that if you plug in a microSD card, keyboard, mouse, monitor, and power supply, it boots into a desktop environment and you can do exactly what you expect you can do with a computer: browse the web, send an email, watch a video, play a game, write a paper, or work on a spreadsheet.

I know that 'Raspberry Pi is a computer' might be a really basic fact for readers of The MagPi, but it's a really important point to make to people who are new to this community. A Raspberry Pi certainly doesn't look, and isn't priced, like a personal computer, so you can imagine that it sometimes takes some gentle persuasion – or perhaps a hands-on demo – to convince people that the Raspberry Pi is indeed a computer, and that it works just as they expect. I don't blame people for being sceptical – after all, the Raspberry Pi is a pretty special piece of hardware.

Adaptable and affordable

It's also a good idea to explain that there's more to the story. Raspberry Pi is no ordinary computer in so many ways. For one, it's probably the most affordable computer, in absolute terms and pound for pound. Additionally, Raspberry Pi's low power consumption, small size, and GPIO pins give it the versatility to be used to create things beyond the capability of an ordinary personal computer. For instance, if you wanted to make a mini rover, the Raspberry Pi is the perfect computer to act as the 'brains'. Imagine needing to design your rover to carry a desktop or laptop computer; the power and weight requirements alone would make this task much more difficult.

It's an important distinction about Raspberry Pi to share with people who are new to this realm. Yes, Raspberry Pi is a computer, but it's not just a computer. It's a computer that's also well suited to making things. That's probably what it's best known for, because month after month, this magazine is full of amazingly clever and creative projects that use Raspberry Pi as one of the materials. I think that these projects are so good that they often steal the spotlight from all the 'everyday' uses for Raspberry Pi. This can lead people to forget (or never even realise in the first place) that Raspberry Pi is first and foremost a computer.

The best way to drive home this point is to use the Raspberry Pi as a computer, and share your experience with others. I certainly practise what I preach. Whenever it's possible, I'll use a Raspberry Pi to create and present my slide deck when I give talks at events. And I use it in the office quite a bit. In fact, this very column was written on a Raspberry Pi 3.

With all the amazing projects you can create with a Raspberry Pi, it can be easy to forget that it's not only a great computer for making, but it's a great computer, full stop.

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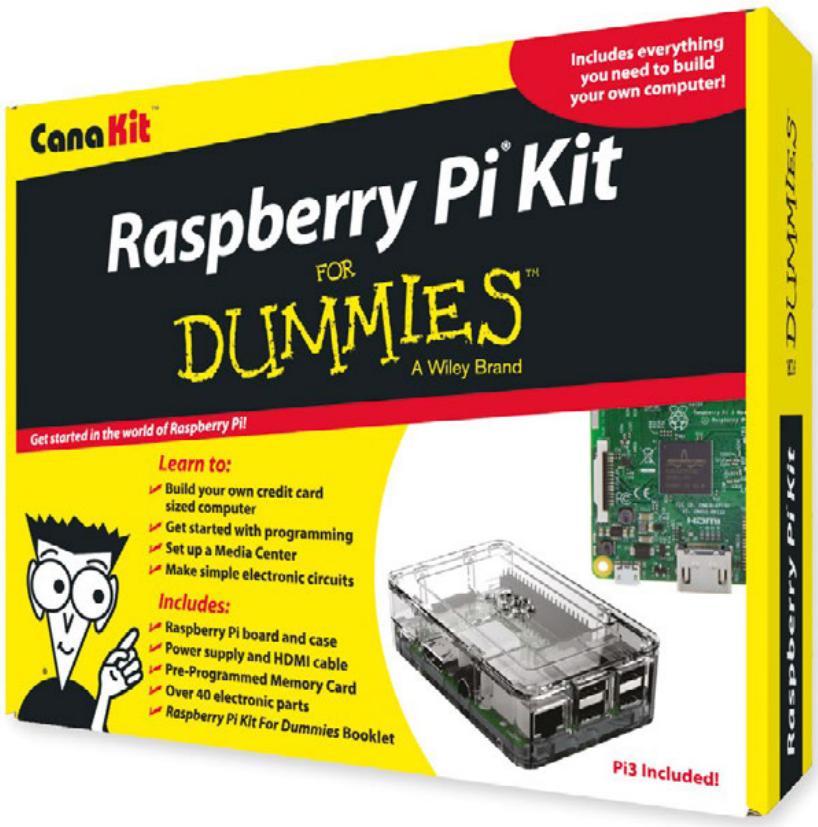

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